DAYTRONIC

MODEL
3363
Manuals 3163 + 3200 + 3300

ANALOG CONDITIONER

INSTRUCTION MANUAL

3000
Instrument Series

Model 3163 Instruction Manual, v. SB.5
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MODEL 3163 ANALOG CONDITIONER

INSTRUCTION MANUAL

Daytronic Corporation

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PLEASE NOTE: Sections 6 and 7, Figures 8 and 9, and Table 2 have been removed from this manual.

If you need information regarding specific 3163 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

INSTRUCTION MANUAL
MODEL 3163 ANALOG CONDITIONER

1. DESCRIPTION

The Model 3163 Analog Conditioner accepts and conditions inputs from dc-to-dc lvdt's, potentiometer-type sensors, Hall-effect devices, photocells, current shunts, and other analog voltage sources with various grounding configurations and voltage and impedance levels. The output is the standard Five-Volt Data Signal Level of the *3000 Series* Instruments and is available at three different output terminals, each having a different bandpass: (1) dc to 2 kHz, (2) dc to 200 Hz, and (3) dc to 2 Hz. Active low-pass filters are used to achieve the 200-Hz and 2-Hz cutoff frequencies. The filtered outputs provide averaging or smoothing of signals containing noise or other dynamic components to allow a stable digital indication and precise, jitter-free control action. The Model 3163 is shown in Figure 1 and the specifications are given in Table 1.

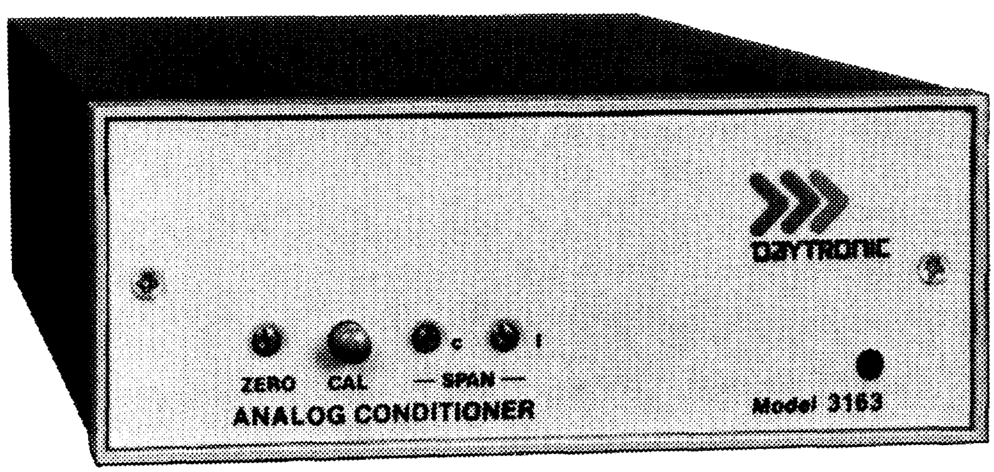


Figure 1. Model 3163 Analog Conditioner

Table 1. Specifications

Input Type: Floating differential; 2, 3, or 4 wire.

Input Sensitivity: Continuously adjustable in four jumper selectable ranges: 50 to 500 millivolts, 500 millivolts to 5 volts, 5 to 50 volts, and 50 to 250 volts.

Input Impedance: One megohm.

Common-Mode Range: ± 100 volts dc.

Common Mode Rejection Ratio: 70 dB, dc to 60 Hz.

Excitation Supply: Regulated 10 volts (±0.02%), 20 milliamperes max.

Analog Outputs: Three analog outputs available; 0 to ± 5 volts with 50% overrange, 5 milliamperes maximum. Bandpass is dc to 2 kHz, dc to 200 Hz, or dc to 2 Hz, depending on output selected. Active low-pass filters provide for rolloff of 60 dB per decade above cutoff frequency. Full-scale slew time is 1.4/f seconds, where f is the cutoff frequency.

Accuracy: 0.1% of full scale for 60 days ("hands off") following initial calibration by user.

Dimensions: 1.7 x 4.41 x 8.5 (HWD inches).

Operating Temperature Range: 0 to 130 degrees F.

Power Requirements: 105 to 135 volts ac, 50 to 400 Hz at 5 watts maximum.

The Model 3163 has an isolated, floating differential input with wide common-mode range and excellent common-mode rejection. This allows even low-level signals to be obtained, essentially free from common-mode offset problems of either an ac or dc nature, from off-ground sources.

The signal source configuration can be either 2-, 3-, or 4-wire, as shown in Figure 2. A regulated 10-volt power supply is contained within the 3163 to permit the excitation of potentiometers, dc-to-dc lvdt's, and similar devices. A half-bridge terminal allows zero-center operation of potentiometers. Zero adjustment of tare input values is also included.

The input range is adjustable from ±50 millivolts to ±250 volts, full scale, to accommodate virtually any level requirement. Front-panel *Coarse* and *Fine* SPAN controls allow convenient scaling of the output signal for digital display in the appropriate engineering units.

Calibration of the 3163 is accomplished by replacing the input signal with a precise, internally-generated reference voltage. The *calibration* mode can be entered either by pressing the front-panel CAL pushbutton or by shorting terminals at the instrument I/O connector with an external switch, transistor turn on, or similar technique.

The Model 3163 Analog Input Conditioner is also available in two additional forms. The Model 3263 contains a Digital Indicator to view the analog output of the

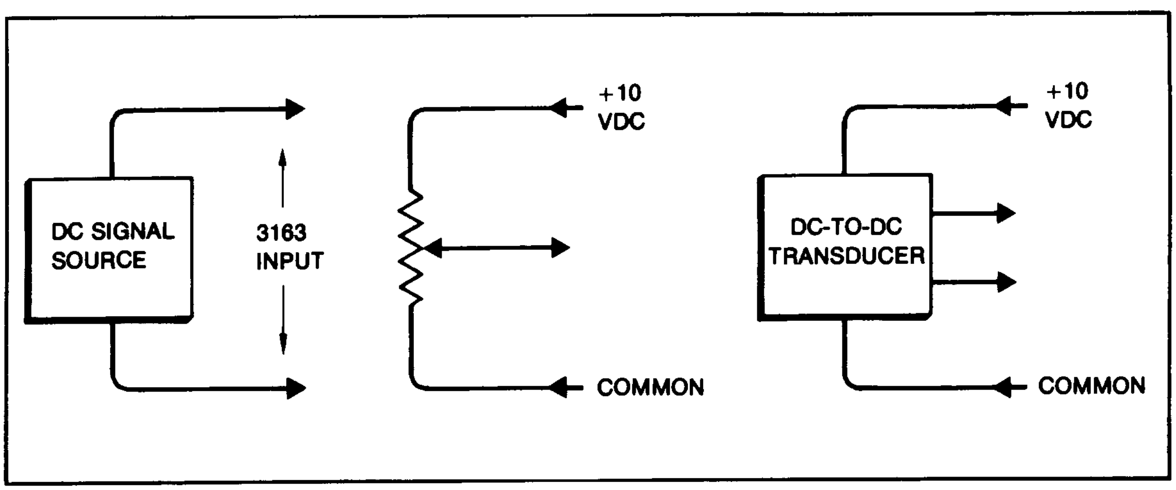


Figure 2. Signal Source Wiring

conditioner. The Model 3363 includes a Limit section (in addition to a Digital Indicator) which provides High/OK/Low indications and outputs. The Digital Indicator and Limit features are standard to all *3000* Instruments and are covered in separate instruction manuals.

2. INSTALLATION AND CABLING

The following paragraphs provide the instructions for instrument installation and cabling.

MOUNTING. The *3000 Series* Instruments can be operated as bench-top units or they can be rack- or panel-mounted. Clearance dimensions for a bench-mounted instrument are given in Figure 3. Panel cut-out dimensions for panel mounting are also shown in Figure 3. From one to four 3000 Series Instruments can be mounted in a 19-inch rack using the 1 3/4 inch high Model 3004 Rack Adaptor. Rack-mounting dimensions are also given in Figure 3. To panel mount an instrument, proceed as follows. Refer to Figure 4.

(a) Remove the front panel by removing two 2-56 x 3/8 flat-head screws.

(b) Remove the front bezel by removing the four 6-32 x 5/8 fillister-head screws.

(c) Make the panel cutout and drill the screw clearance holes indicated in Figure 3. The front bezel can be used as a template to define the rectangular cutout and locate the clearance holes.

(d) Hold the instrument enclosure behind the panel and reattach the front bezel to the enclosure from the front of the panel with the four mounting screws.

(e) Reinstall the front panel.

(f) Tighten the two securing screws of the rear-panel instrument I/O connector to ensure that the connector is seated and that the conditioner printed-circuit board is pushed fully forward so that the front-panel screwdriver adjustments and pushbuttons are accessible. These screws give approximately 1/8 inch of adjustment; consequently, this is the maximum panel thickness that should be used.

IMPORTANT: The unit is shipped with two **spacer washers** on the securing screws of the rear-panel I/O Connector. When **panel-mounting** the unit, you MUST REMOVE THESE WASHERS, so that the printed-circuit board may move forward about 1/8" during Step (f).

CAUTION

Do not overtighten the connector securing screws or resultant damage may occur to the printed circuit board.

AC POWER CONNECTION. To protect operating personnel, the *3000 Series* Instruments are equipped with a three-conductor power cord. When the cord is plugged into the appropriate receptacle, the instrument is grounded. The offset pin on the power cord is ground. To maintain the safety ground when operating the instrument from a two-contact outlet, use a three-prong to two-prong adaptor and connect the green pigtail on the adaptor to ground.

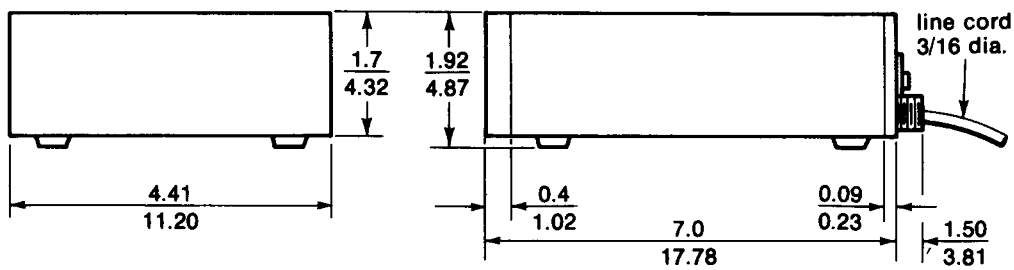
To prepare the instrument for operation, connect the power cable to a 105-135 volt ac, 50-400 Hz power source. The instrument can use up to 5 watts of power.

RANGE SELECTION. The input range of the Model 3163 is determined by jumper connections made at the instrument I/O connector. The full-scale input ranges provided are: (1) 50 to 500 millivolts, (2) 500 millivolts to 5 volts, (3) 5 to 50 volts, and (4) 50 to 250 volts. The jumper connection(s) used for each full-scale range are indicated in Figure 5(A).

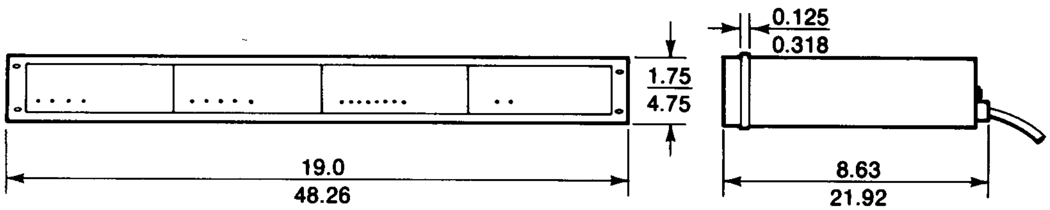
INPUT CABLING. Cabling from the external analog source to the 3163 is accomplished via the supplied instrument I/O connector. The I/O connector pin numbers and functions are given in Figure 5. The 3163 has a floating differential input, and two-wire shielded cable is normally used for the input cabling. See Figure 5(B).

AUXILIARY SUPPLY CONNECTIONS. A 10-volt regulated power supply capable of delivering up to 20 milliamperes is included in the 3163 to power dc-to-dc transducers, potentiometers, and other such devices. Figure 5(C) shows a potentiometer connected to provide a zero-to-full scale output as the potentiometer wiper is moved. Figure 5(D) shows a potentiometer connected to provide a bipolar output (zero center). Figure 5(E) gives the wiring configuration for connecting the 3163 to a dc-to-dc transducer.

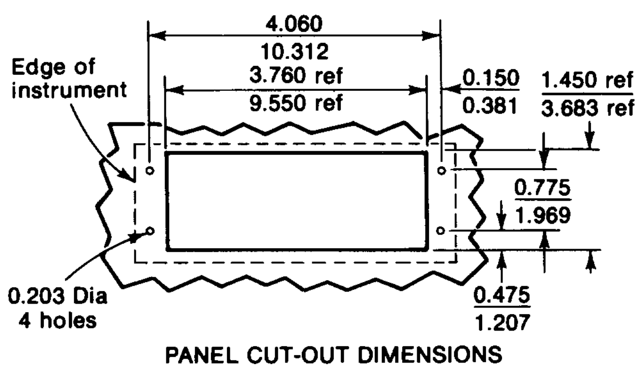
ANALOG OUTPUTS. Three different analog outputs are available at the instrument I/O connector. Each output has a different passband: dc to 2 kHz, dc to 200 Hz, and dc to 2 Hz. The 200-Hz and 2-Hz cutoff frequencies are achieved with



A. Bench Mounting



B. Rack Mounting



C. Panel Mounting

Figure 3. Instrument Mounting Dimensions

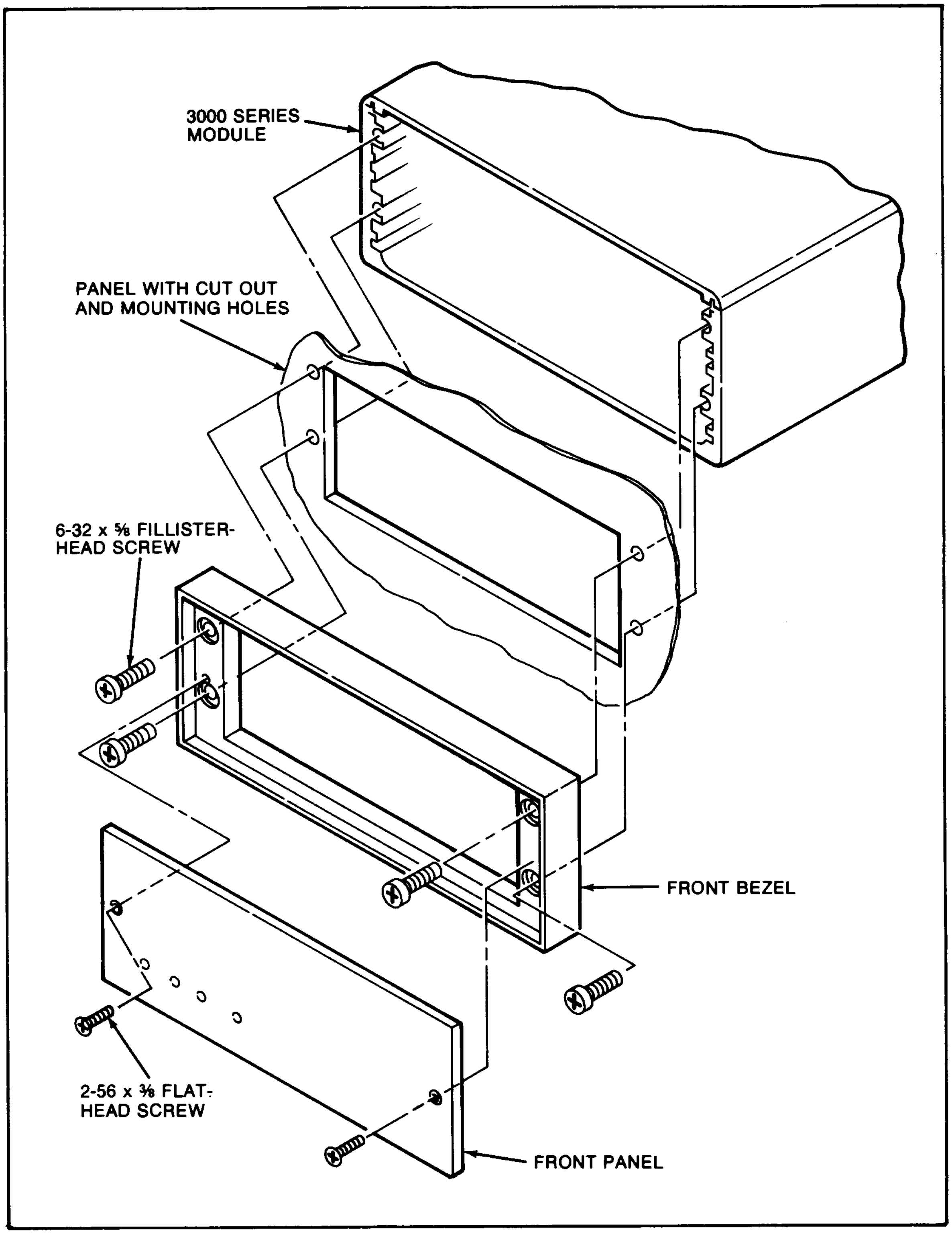


Figure 4. Instrument Panel Mounting

active low-pass filters. As the cutoff frequency is lowered, a trade off is made between noise elimination and increased time-to-answer or slew time. Each output has a 60-dB rolloff a decade from the cutoff frequency. The filter characteristics are given by the following equations.

$$A_{out} @ f_0 = 0.7 \, A_{in}$$

$$A_{out} @ 10f_0 = 0.001 \, A_{in}$$

where A_{out} = output amplitude

A_{in} = input amplitude

f_0 = selected cutoff frequency

T = time-to-answer in seconds (output of filter within 0.1% of final value after step function is applied).

REMOTE CALIBRATION CHECK. The instrument can be placed in the *calibration* mode by shorting pins 10 *(Signal Common)* and 8 *(Remote Cal)* of the I/O connector. Figure 5(F) indicates three methods of remotely entering the calibration mode (external switch, transistor, or TTL source). The *Remote Cal* function provides a convenient means for periodically monitoring calibration of the instrument from a remote location without pressing the front-panel CAL button.

3. CALIBRATION

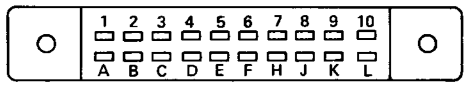
This section contains the instructions for calibrating the Model 3163. Included is a functional description of the instrument front panel (see Figure 6). To perform calibration, proceed as follows.

(a) Turn power ON by placing the rear-panel slide switch in the ON position. The front-panel indicator should light to indicate the application of ac power.

(b) With the external device in a zero output condition, set the 3163 output to zero using the front-panel ZERO control. In some instances, an integral digital indicator will be used to display the conditioner output (Model 3263 or 3363). When only the conditioner is supplied (3163), an external indicator must be used to monitor the conditioner output.

DAYTRONIC 3X63 INSTRUMENT I/O
CONNECTOR W/PIN DESIGNATIONS
(X=1, 2, or 3, e.g. 3163, 3263, or 3363)

Fig. 5 I/O Wiring Data



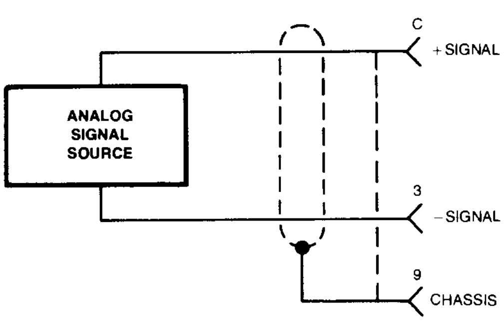
AMPHENOL 225-21021-103 REARVIEW

PIN		PIN	
1	1/2 BRIDGE (+5 V)	A	POWER COMMON (10 V AUXILIARY SUPPLY
2	ISOLATED COMMON	B	+10 V AUXILIARY SUPPLY
3	−SIGNAL INPUT	C	+SIGNAL INPUT
4	50 MV/500 MV RANGE	D	50 MV/500 MV RANGE
5	500 MV RANGE	E	500 MV RANGE
6	5 V RANGE	F	5 V RANGE
7	50 V RANGE	H	50 V RANGE
8	REMOTE CALIBRATION	J	ANALOG OUTPUT, ±5 V-DC TO 2 HZ
9	CHASSIS	K	ANALOG OUTPUT, ±5 V-DC to 200 HZ
10	OUTPUT SIGNAL COMMON	L	ANALOG OUTPUT, ±5 V-DC TO 2 KHZ

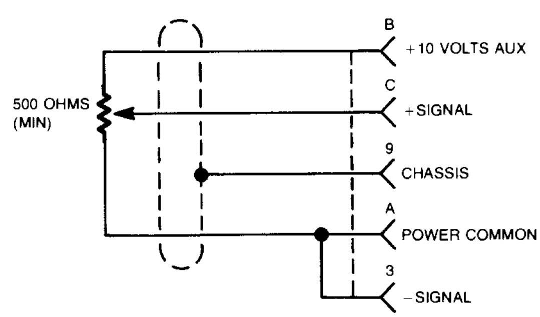
RANGE SELECT JUMPER CONNECTIONS

RANGE	JUMPER
50 TO 500 MV	D TO 4
500 MV TO 5 V	D TO 4 AND E TO 5
5 TO 50 V	F TO 6
50 TO 250 V	H TO 7

A. I/O Pin Assignments and Range Selection

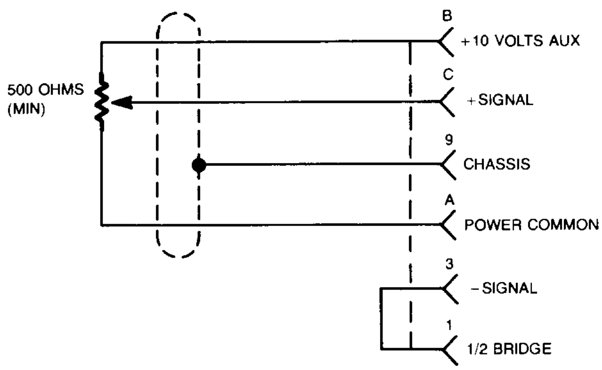


B. External Analog Signal Source

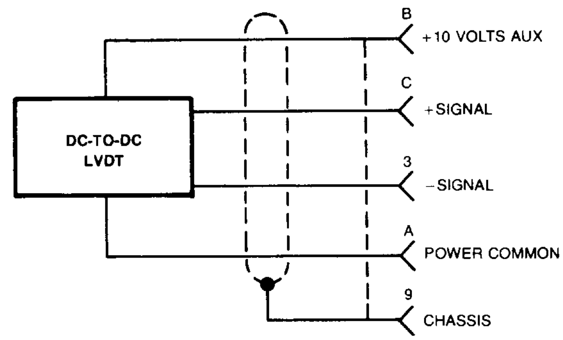


C. External Potentiometer, Zero to Full Scale

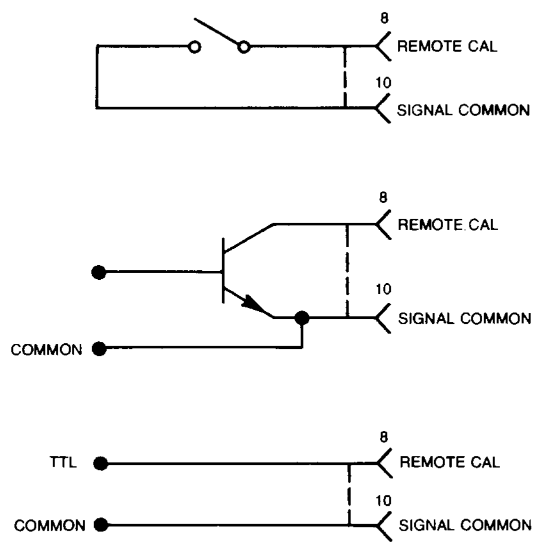
Fig. 5 (cont'd)



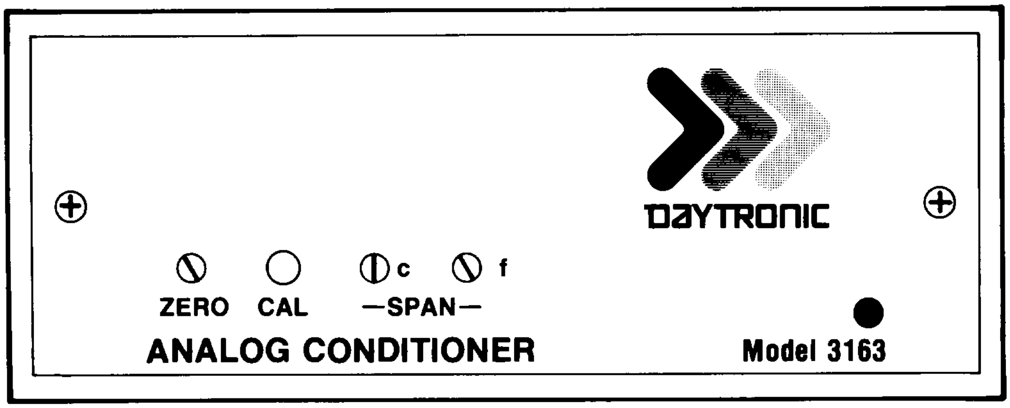
D. External Potentiometer, Zero Center



E. DC-to-DC LVDT



F. Remote Calibration Connections



ZERO Control: Sets the instrument output to zero with a zero input signal applied.

CAL Pushbutton: When pressed, the CAL pushbutton causes the input signal to be replaced by an internally-generated dc reference level. This level can be adjusted by an internal ***Cal Level*** switch so that the analog output of the instrument is equal to or less than the value obtained with a full-scale input. This output is called the full-scale calibration value. The CAL pushbutton is used with the ***Coarse*** and ***Fine*** SPAN controls to calibrate the instrument.

SPAN Controls: The ***Coarse*** and ***Fine*** SPAN controls are used to set the instrument output to the full-scale calibration value or the full-scale value produced with an equivalent input.

Figure 6. Front-Panel Description

(c) Arrange for the input device to produce a known up-scale output that is greater than one-half of full scale. Adjust the *Coarse* and *Fine* SPAN controls until the output signal causes a reading equivalent to the input value.

(d) Remove the front panel as described in Section 2. Press the CAL pushbutton and set the internal *Cal Level* switch for the output reading nearest to, but not exceeding, the full-scale output of the 3163. Since this reading is related to the proper SPAN control settings for a known input, it can be recorded for use in future calibration checks or recalibration.

To calibrate the instrument in the future, simply press the CAL push-button and adjust the SPAN controls to obtain the reading recorded during the initial calibration.

(e) Replace the front panel of the instrument.

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Model 3163 works by using a simplified block diagram of the conditioner. This is not intended to be used as a detailed theory of operation discussion for personnel untrained in electronic technology, but as a simplified explanation of the detailed schematic diagram provided with this manual. Throughout the following, refer to Figure 7.

POWER SUPPLIES. Primary power (115 volts ac, 50-400 Hz) is applied to the instrument by means of a rear-panel ac connection point and the supplied three-conductor power cord. A rear-panel slide switch is used to turn ON primary power. Overload protection is provided by a 0.25 ampere fuse mounted near the ac connection point. When the slide switch is ON, primary power is applied to the power transformer which provides the necessary power-line isolation and the low ac voltages required to develop the regulated dc voltages used in the 3163. The secondary of the power transformer has a grounded center tap, and a diode bridge functions as two full-wave rectifiers to produce ±9 volts regulated dc. Two three-terminal integrated-circuit *Regulators* are used to develop these regulated voltages. The reference terminal of each *Regulator* is biased with one or two diodes to make certain that a minimum regulated voltage of 9 volts is achieved. The proper diode biasing is accomplished at factory check out.

A dc reference voltage of +2.5 volts is further developed from regulated +9 volts by the use of a third three-terminal *Regulator*. This precision dc reference is used in the *Auxiliary Power Supply* circuit and, when the instrument is so equipped, in the *Digital Indicator* and *Hi/Lo Limits* circuits. The *Auxiliary Power Supply* circuit is discussed in a following paragraph.

The -9 volts regulated is used to light the front-panel indicator (LED) which indicates the application of ac power to the instrument.

The + unregulated voltage from the diode bridge is used to develop the +10 volt output of the *Auxiliary Power Supply*. In addition, this voltage is routed to the

Digital Indicator and *HI/LO Limits* circuit boards where it is used to develop +5 volts regulated for the TTL logic employed in these circuits. Refer to the *Digital Indicator* and *HI/LO Limits Instruction Manuals.*

Another transformer secondary is used to develop a regulated ±10 volts isolated supply (isolated from the output *Signal Common*). The use of this supply in the signal conditioner input circuitry makes possible the high common-mode range of the 3163.

A third transformer secondary supplies 5 volts ac to the *Digital Indicator* circuit board (when supplied). This ac voltage is used to develop an unregulated +6 volts dc. Refer to the *Digital Indicator Instruction Manual.*

The +10 volts *Auxiliary Power Supply* is developed from the + unregulated voltage as previously stated. The +10 volts *Auxiliary* is available at the instrument I/O connector for use as excitation for dc-to-dc transducers or external potentiometers. In addition, a *Half-Bridge* output is available. The connection point of two equal resistors (Rl-R2) placed across the power supply output is the *Half-Bridge* output (+5 volts). When the *Half-Bridge* output is connected to the *–Signal* input, the wiper of a potentiometer connected across the *Auxiliary Power Supply* can vary from +5 volts to -5 volts. This wiring arrangement is illustrated in Figure 5.

Transistor Ql functions as an emitter-follower series regulator, with an operational amplifier providing the regulation control. The plus terminal of the *Control Amplifier* is biased from the +2.5 volt Reference. The minus terminal is normally at +2.5 volts through the dividing action of resistors R3 and R4. As the output of the Auxiliary Power Supply varies, the Control Amplifier output varies accordingly and provides a base drive to Ql to maintain the supply output at +10 volts. A Zener diode in series with the output of the Control Amplifier acts as a *Level Translator* so that the amplifier can operate near its mid-range.

Transistor Q2 functions as a *Current Limiter* in the event that the supply output is accidentally shorted or otherwise overloaded. When the current through resistor R5 becomes great enough to forward bias Q2, transistor Q2 is turned on, and current is shunted through R6 and Q2, with the raw dc voltage now being dropped across R6.

CALIBRATION CIRCUIT. The *calibration* mode is entered when either the front-panel CAL button is pressed or the *Remote Cal* line is shorted to *Signal Common* at the Instrument I/O connector. Either of these conditions cause the output state of a *Comparator* to change. An *Optical Isolator* is controlled by the *Comparator* output, and its output controls *Analog Switches* Sl, S2, and S3. The *Optical Isolator* is required since the 3163 input circuitry is powered from the isolated power supplies to allow operation from sources having off-ground or common mode voltages on their outputs.

When the 3163 is in the *calibration* mode, the input signal is disconnected from the *Input Amplifier* and replaced by an internally generated calibration voltage. This voltage is developed by a three-terminal *Regulator* from the +10 volts isolated. The output of the *Regulator* (+2.5 volts isolated) can be divided by a series of parallel resistances which are connected to the *Regulator* through switches. These switches in actuality are a single internal switch termed the *Cal Level* switch. The switch is a rotary type switch with ten positions, each of which yields up to four contact closures corresponding to the four weights of binary-coded decimal (BCD), that is, 1, 2, 4, and 8. The ten positions allow various combinations of contact closures, thus providing various *Cal* Levels to the *Input Amplifier* via *Analog Switch* Sl. The user selects the *Ca1 Level* that provides a full-scale output indication less than, but closest to, that observed when a full-scale input signal is applied. The indication can then be used as a calibration value for future calibrations.

Analog Switch S2 is used during calibration to remove any offset imposed on the *Input Amplifier* by the ZERO control. *Analog Switch* S3 is used during calibration to remove a gain factor incorporated when the 500 millivolt-to-5 volt full-scale input range is selected. These functions are more completely described in the following paragraphs.

SIGNAL CONDITIONER. The input signal is applied to a resistance divider arrangement that has various taps to the *Input Amplifier.* The full-scale input range is determined by the tap used, and tap selection is accomplished with jumper-wire connections at the I/O connector. However, two of the available ranges (5 mv to 500 mv and 500 mv to 5 v) use the same tap point. The difference in signal levels encountered for the two ranges is compensated by changing the gain of the *Input Amplifier*. This is accomplished by installing a second jumper when the 500 millivolt-to-5 volt range is selected. This jumper places a short across a feedback resistor (R8) in the *Input Amplifier* circuit, increasing feedback, thereby decreasing gain. When the calibration mode is used, the gain correction is removed via *Analog Switch* S3.

The *Coarse* SPAN control also affects the gain of the *Input Amplifier* and is used for scaling the instrument output. The ZERO control provides a means of offsetting the output of the *Input Amplifier*. This zero offset voltage is eliminated during calibration by *Analog Switch* S2.

The +*Signal* input, after being properly divided, is applied to the plus terminal of the *Input Amplifier,* a non-inverting operational amplifier which is powered from the ±10 volt *Isolated Supplies.* The minus terminal of the amplifier is returned to the *Isolated Common* through resistor R7. This arrangement allows the *Input Amplifier* to be totally referenced to the *Isolated Common* which is also the –*Signal* input to the conditioner. Common-mode or offset voltages up to 100 volts can be tolerated by the *Input Amplifier.*

The output of the Input Amplifier is applied to an inverting operational amplifier through resistor R9. The values of resistors R9 and R10 are such that the gain of the amplifier is approximately 1/200. In addition, the amplifier is powered from ±9 volts regulated, and the plus terminal of the amplifier is returned directly to *Signal Common.* To comply with the summing point restraint of the amplifier, its output must go to the value which allows the minus terminal to be at the same potential as the plus terminal. An offset voltage of 10 volts at the output of the *Input Amplifier* would take the output of the inverting amplifier to -0.05 volts, and the offset would be dropped across resistor R9.

A second inverting amplifier with a gain of 200 is used to reamphfy the signal to its original level and return the proper signal polarity. It has the same configuration as the first amplifier, but the values of R11 and R13 are such to provide again of 200. Also, resistor R12 is returned to the *Isolated Common* so that the R11 and R12 junction is held at 0 volts or *Signal Common.* Since the plus terminal of the amplifier is tied to *Signal Common*, the output of the amplifier is quiescently at 0 volts also, the desired condition with an offset input but no signal input.

The net result of the two inverting operational amplifiers is to provide a gain of unity and the proper conditioning to eliminate offset or common-mode voltages. Only the input signal differential is passed through the amplifiers to the output filtering circuits of the conditioner. The *Fine* SPAN control is located in the feedback circuit of the second amplifier to provide a fine gain adjustment during calibration.

Three analog outputs of the conditioned signal are available at the module I/O connector. The three outputs provide three different passbands of dc to 2 kHz, dc to

200 Hz, and dc to 2 Hz. Output selection is a trade off between eliminating unwanted signals caused by vibration or increasing the time-to-answer (slew rate) of the conditioner. The 200-Hz and 2-Hz cutoff frequencies are achieved with the use of active low-pass filters. The rolloff of each output is 60 dB within a decade of the cutoff frequency.

5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in determining, in the event of a malfunction to which the Model 3163 is suspected of contributing, whether the instrument is functioning normally or whether it is the source of the observed trouble. In the event the unit requires repair, a complete parts list, schematic diagram, and component location drawing are included in this manual. The user may also contact the factory Service Department or the local Daytronic Representative for assistance.

If the instrument is suspected of faulty operation, observe the following steps.

(a) If the unit is totally inoperative (front-panel power indicator does not light), check the primary power fuse (Fl) located on the standup board which forms the power cord connection point. If the fuse is blown, replace it with a 0.50 ampere fuse (see Table 2 for part number). Before reapplying power, visually inspect the power cord and the input power connections for any discrepancy which could have caused the overload.

(b) Disconnect the normal input source and make a jumper connection between pin C (+*Signal*) and pin 3 (–*Signal*) at the instrument I/O connector.

(c) Adjust the front-panel ZERO control and verify that the instrument output can be set to zero.

(d) Press the front-panel CAL button and observe an up-scale output indication. Set the module output to the full-scale calibration value using the *Coarse* and *Fine* SPAN controls. Steps (b) thru (d) verify the ability of the amplifier circuitry to adjust to zero and respond to the internal calibration signal. If this check is passed, the conditioner amplifier circuits are functioning normally. Check the instrument I/O connector for proper wiring of the input before proceeding. See Figure 5.

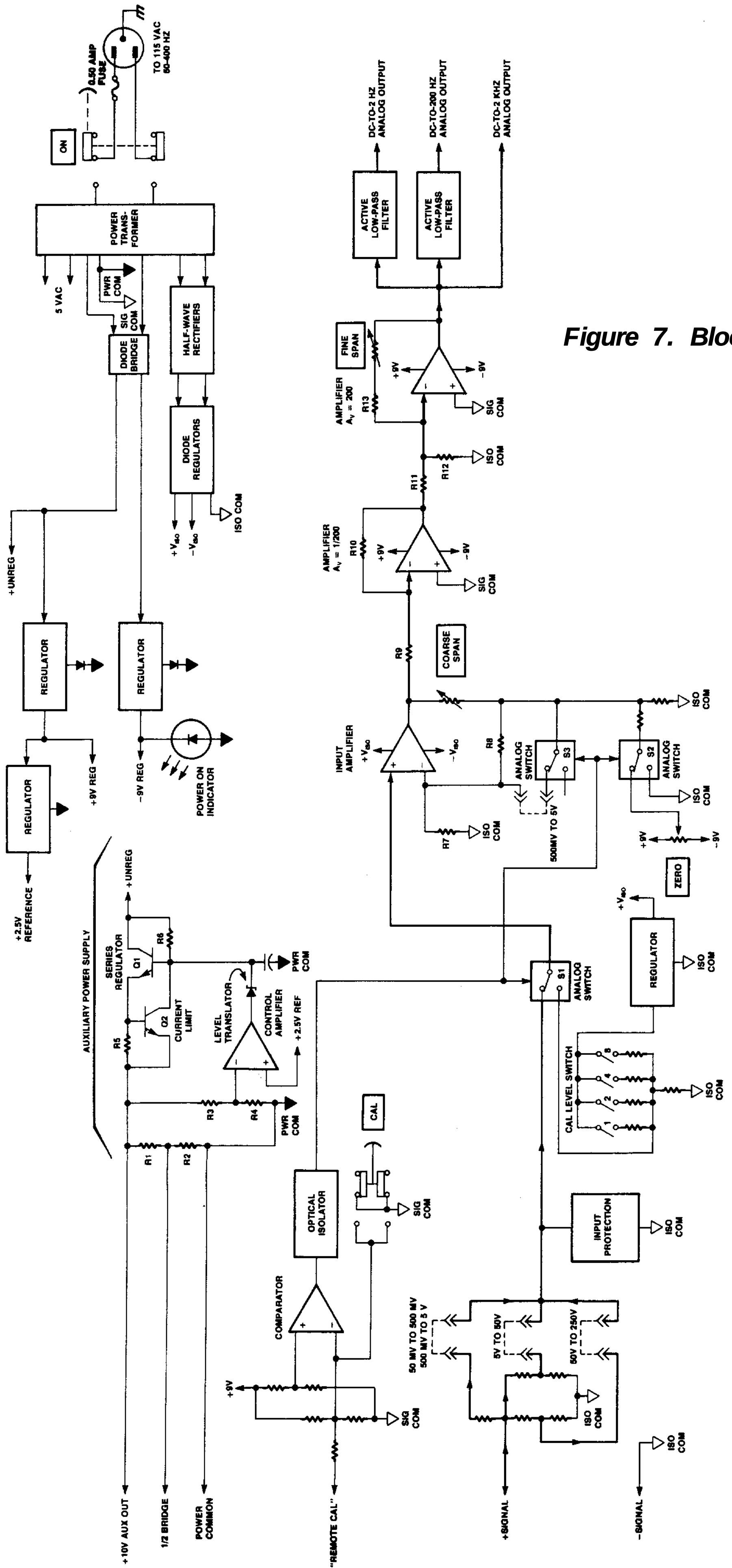


Figure 7. Block Diagram

(e) If an unstable digital display or excessive output noise is encountered, the problem may be in the output filter circuits. The 2-Hz and 200-Hz outputs use active low-pass filters. The 2-kHz output is provided directly from the conditioner output amplifier. In general, if a problem is encountered with either the 2-Hz or 200-Hz output, but the problem disappears when another output is used, a filter circuit is faulty.

(f) The above can be verified by checking each analog output with a test oscilloscope as a square-wave input signal is applied. The time-to-answer in seconds (output of conditioner within 0.1% of final value after step function is applied) should be 0.7 milliseconds for the 2-kHz output, 7 milliseconds for the 200-Hz output, and 0.7 seconds for the 2-Hz output.

(g) If the *Auxiliary Power Supply is* used, connect a test oscilloscope to pins A (*Power Common*) and B (*+10 volts*) at the instrument I/O connector. The oscilloscope should indicate a dc level of approximately 10 volts that is free of excessive noise and ripple.

SB.5

MODEL

3200 / 3300

DIGITAL INDICATOR

INSTRUCTION MANUAL

3000

Instrument Series

Model 3200/3300 Instruction Manual, v. SB.5
Pub. No. 3200/3300M.5, Issued 10/96
Part No. 91130

DAYTRONIC

MODEL

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DIGITAL INDICATOR

INSTRUCTION MANUAL

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PLEASE NOTE: Sections 6 and 7, Figures 6 and 7, and Table 3 have been removed from this manual.

If you need information regarding specific 3200/3300 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

INSTRUCTION MANUAL
3200/3300 SERIES DIGITAL INDICATOR

1. DESCRIPTION

The *3000 Instrument Series* is a family of premium signal conditioning instruments that includes models to accomodate virtually all types of transducers and signal sources commonly encountered in electro-mechanical testing and control operations. The *3000 Instruments* are available in three forms: *Form 1* contains the Signal Conditioner only; *Form 2* is the Signal Conditioner with Digital Indicator; *Form 3* is the Signal Conditioner with Digital Indicator and Hi-Lo Limits. The Model numbering system used with the *3000 Series* identifies the form and the type of signal source. This numbering system is further explained in Table 1. From Table 1, it can be seen that all models having a Digital Indicator are identified by a 32XX or 33XX number, with the last two digits identifying the type of signal source (thermocouple, LVDT, etc).

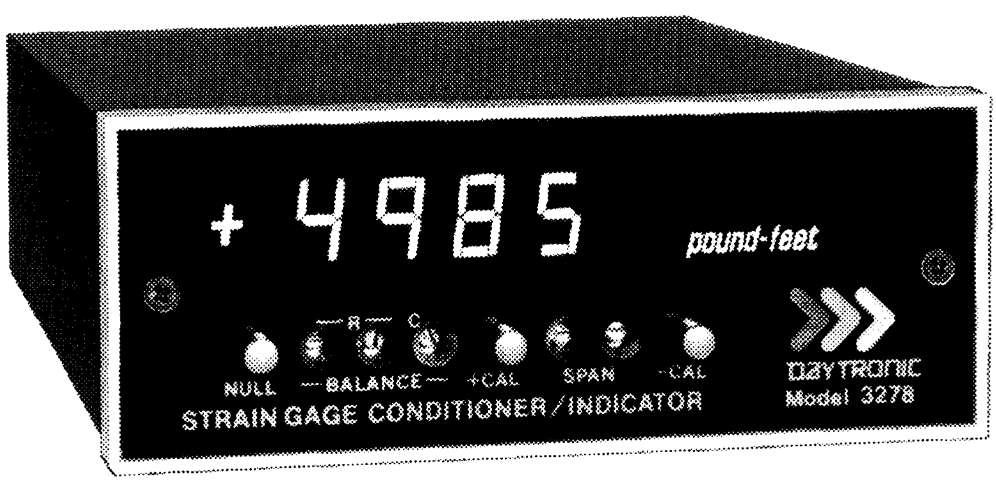

Figure 1. 3000 Series Instrument with Digital Indicator

Table 1. 3000 Series Model Numbering

Model 3 X X X

"3" is series identifier, used with all units:

Second digit identifies "form":

"1" = signal conditioner only
"2" = signal conditioner with digital indicator
"3" = signal conditioner with digital indicator and Hi-Lo limits

Third and fourth digits identify type of signal source:

"10" = Type J Thermocouple
"11" = Type K Thermocouple
"15" = Thermistors
"30" = LVDT's
"40" = Pulse Pick-up's (Frequency)
"63" = DC Volts/Millivolts/ DC-DC LVDT's/Potentiometers
"70" = Strain Gages (DC excited)
"78" = Strain Gages (AC excited)
Etc.

The *3000 Series* instruction manual system is designed to provide the user with the following documentation: (1) a separate instruction manual for each type of Signal Conditioner purchased; (2) an instruction manual covering only the Digital Indicator section of a *3000 Series* instrument, but applicable to any *Form 2* or *Form 3* instruments; and (3) an instruction manual covering only the Hi-Lo Limit section of a *3000 Series* instrument, but applicable to any *Form 3* instrument. It is the purpose of this manual to cover the Digital Indicator section of all *Form 2* and *Form 3* instruments.

The Digital Indicator section of any *Form 2* or *Form 3* instrument consists of a printed-circuit board on which are mounted the required circuit components for digitizing the analog output of the Signal Conditioner and the light-emitting-diode (LED) display. This board is mounted above the circuit board which contains the components for the Signal Conditioner. The digits which comprise the display are mounted on a small board which is affixed to the digitizer board with a right-angle printed-circuit board header. The *Form 3* instruments contain an additional printed-circuit board for the Hi-Lo Limit circuitry.

The LED display is comprised of six orange digits with polarity sign. The 0.4 inch height of the digits, combined with the inherent brilliance of an LED type of display, make the display easily discernible in normal room lighting. The display is viewed through the red plastic front panel of the instrument to provide filtering of external light and enhance the display brilliance. The front panel is opaque except for that portion through which the display is viewed. A typical *3000 Instrument* with Digital Indicator is shown in Figure 1.

The Digital Indicator scaling is selected with rear-panel pushbutton switches. Full-scale values of ±5000 counted by *1's*, ±10000 counted by *2's*, or ±20000 counted by *5's* can be selected. The most significant digit (MSD) of the display contains the polarity sign and is either unlit or lights as a *1* for displays of 10000 or greater. The least significant digit (LSD) is a dummy zero which can be turned ON or left unlit as desired. In addition, decimal-point position can be selected to give display readings as follows: 1.XXXX, lX.XXX, 1XX.XX, 1XXX.X, or 1XXXX (no decimal point). Decimal-point location and dummy zero selection are also accomplished with rear-panel switches (miniature slide-switch bank). When the 20000 scale is selected, the display is digitally limited to read a maximum number of 19995 since the MSD is either unlit or reads a "1" for displays of 10000 or greater. The 5000 and 10000 scales are analog limited to an overrange of approximately 5600 and 11200, respectively. An overrange condition on any range is indicated by a flashing display. The sampling rate of the display is 3 samples per second. The Digital Indicator specifications are summarized in Table 2.

Table 2. Specifications

Display: Orange LED's, six digits with polarity sign, 0.4 inch height. MDS is either unlit or reads a 1 and contains the polarity sign. LSD is a dummy zero which can be programmed to be lit or unlit (rear-panel switch).
Scaling: Selectable at rear panel; full-scale values of ±5000 counted by *1's*, ±10000 counted by *2's*, or ±20000 counted by *5's*.
Decimal Point: Decimal-point location can be selected with rear-panel switches as follows: 1.XXXX, 1X.XXX, 1XX.XX, 1XXX.X, or 1XXXX (no decimal point).
Sampling Rate: 3 samples per second.
Legends: Each instrument supplied with an appropriate assortment of user-installable rub-on engineering unit legends.

2. INSTALLATION

The *3000 Series* Instruments can be operated as bench-top instruments or they can be rack- or panel-mounted. Dimensions for all three types of mounting and corresponding mounting instructions are given in the accompanying Signal Conditioner *Instruction Manual*. The following paragraphs provide the instructions for legend installation, scale selection, decimal point/dummy zero selection, and ac power connection.

Legend Installation. A sheet of dry-transfer lettering is supplied with each instrument to provide the user with a means of affixing an engineering-unit legend to the front panel. The sheet contains the common engineering units encountered in making electro-mechanical measurements and additional alpha-numeric characters. Space is supplied on the front panel to affix the desired legend to the right of the display. To affix the legend to the front panel, press the dry-transfer sheet firmly against the panel with the desired legend or character situated in place. Rubbing the legend or character with a ball-point pen will cause the legend to be transferred onto the panel. The legend can be protected from scratches which may occur during calibration/operation of the instrument by lightly spraying it with Krylon #1306 Workable Fixative.

If it is desired to change a legend, remove the legend to be replaced by pressing masking tape against the legend, then pulling off the gummed tape.

Scale Selection. Figure 2 shows the full-scale display for the three selectable scales: ±5000 counted by *1's*, ±10000 counted by *2's*, and ±20000 counted by *5's*. The figure also indicates the last active digit and the dummy zero which can be lit for any scale selection. The first digit of the display contains the polarity sign and lights as *1* on the 10000 and 20000 scales for values equal to or greater than 10000. On the 20000 range, because the most significant digit is either unlit or a *1* and the count is by *5's*, the greatest number which can be displayed is 19995. Of course, this would be displayed as 199950 if the dummy zero were lit.

Scale selection is accomplished with the two pushbutton switches located at the rear panel. The panel is marked to indicate which switches are pushed IN or left OUT for the corresponding scale selection. The switches have a push-push action and are illustrated, with the scale selection coding, in Figure 3. With both switches OUT, the ±5000 range is selected. With the left switch OUT and the right switch IN, the ±10000 range is selected. With the left switch IN and the right switch OUT, the ±20000 range is selected.

Decimal Point/Dummy Zero Selection. Decimal-point location and dummy-zero activation are selected with a rear-panel miniature slide switch bank. The switch bank is marked on the rear panel as shown in Figure 3. The decimal-point position can be fixed at any one of the display locations indicated on Figure 3. Place any one of slide switches 1 through 4 ON to light the decimal point at the desired location. Place slide switch 5 ON if no decimal point is to be lit. To activate the dummy zero (digit to the right of last active digit will continuously light as a zero), place slide switch 6 ON.

AC Power Connection. To protect operating personnel, the *3000 Series* Instruments are equipped with a three-conductor power cord. When the cord is plugged into the appropriate receptacle, the instrument is grounded. The offset pin on the

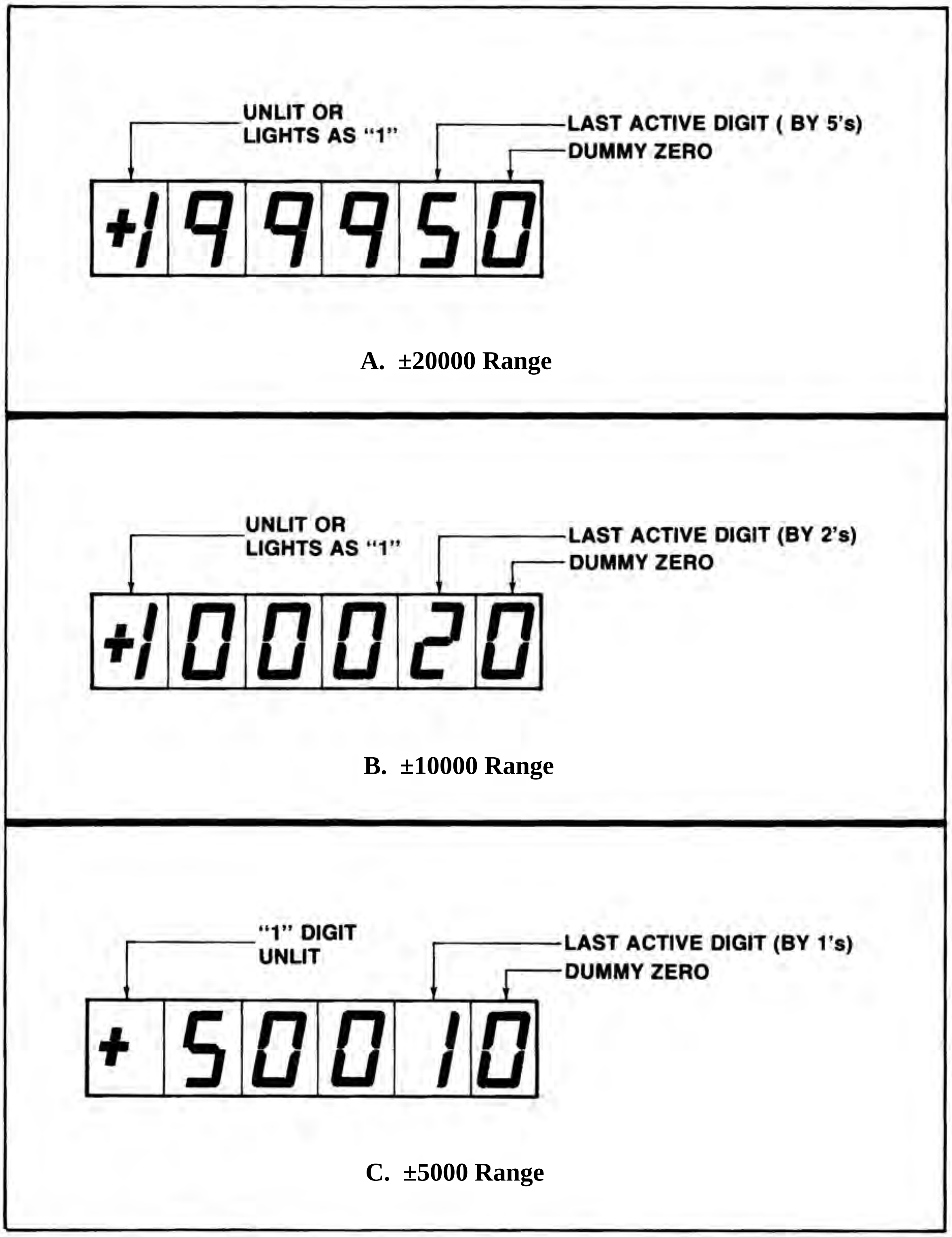

Figure 2. Full-Scale Displays for Three Ranges

power cord is ground. To maintain the safety ground when operating the instrument from a two-contact outlet, use a three-prong to two-prong adaptor and connect the green pigtail on the adaptor to ground.

To prepare the instrument for operation, connect the power cable to a 105-135 volt ac, 50-400 Hz power source. The instrument can use up to 5 watts of power.

3. OPERATION

The only operation required is turning ON/OFF ac power to the instrument. This is accomplished with the rear-panel slide switch (see Figure 3). The display lights immediately when ac power is ON.

NOTE

In all instances, a flashing display indicates that an overrange condition has occurred, and it is likely that the Signal Conditioner amplifiers are being overdriven. The 5000 and 10000 ranges are analog limited at approximately 5600 and 11200, and while a number may be displayed, if

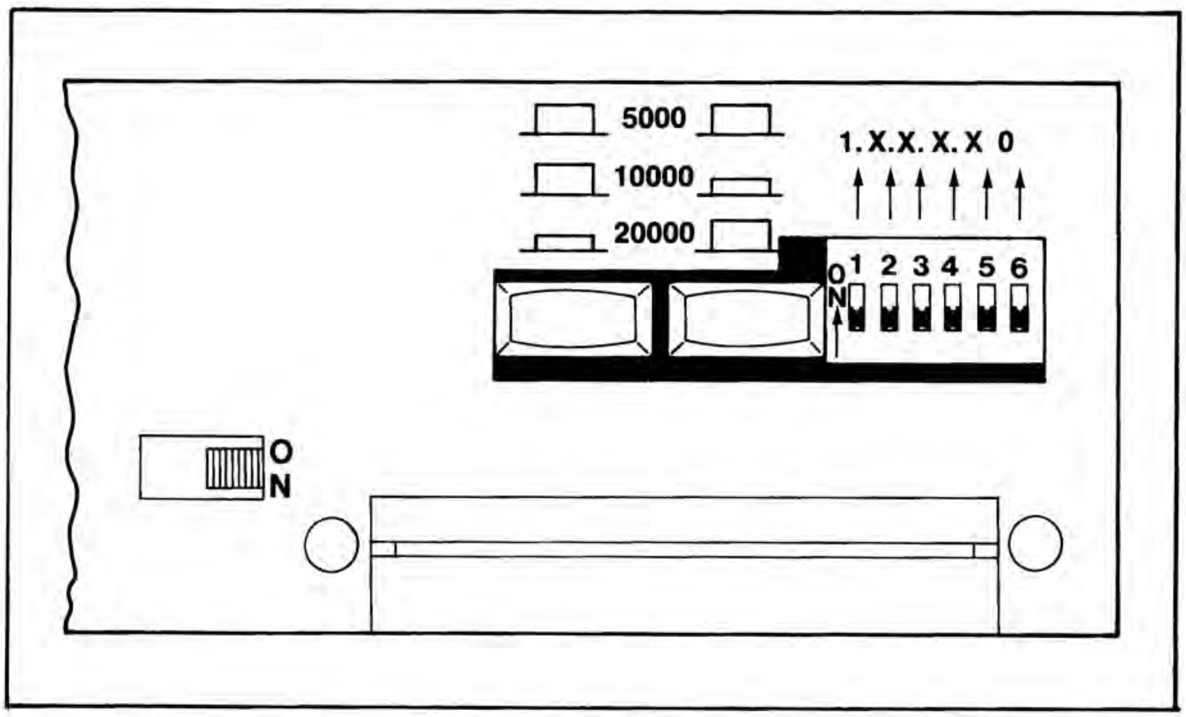

Figure 3. Scale, Decimal Point, Dummy Zero Switches

the display is flashing an overrange condition has occurred. Consequently, the displayed value may be invalid. The 20000 range is digitally limited to 19995. When an overrange occurs on this range, the display will flash all zeros.

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Digital Indicator works by using a simplified block diagram. This section is not intended to provide a detailed explanation of electronic circuits for personnel untrained in electronic technology. However, it provides an adequate overview of operation for those familiar with basic electronic circuit operation. Throughout the following, refer to Figure 5.

Power Supplies. The integrated-circuit chips which comprise the A/D *Converter* and the *Overrange Comparator* are CMOS circuits which require ±9 volts regulated. These voltages are supplied from power supplies contained on the Signal Conditioner circuit board and are discussed in the Signal Conditioner *Instruction Manual*.

The digital part of the *A/D Converter, the Bit Selector,* and the various logic gates and inverters are operated from +5 volts regulated (TTL logic). The +5 volt supply consists of a three-terminal *Regulator.* The unregulated input to the Regulator is obtained from Signal Conditioner circuit board (unregulated side of +9 volt supply).

The *BCD-to-7-Segment, Decoder, Display Drivers,* and *Display LED's* operate from +6 volts unregulated. Five volts ac is supplied from the Signal Conditioner circuit board (secondary of power transformer located on board). Plus 6 volts unregulated is developed with a *Diode Bridge* and *Filter* located on the Digital Indicator board.

A +2.5 volts precision reference is supplied from a precision power supply located on the Signal Conditioner circuit board. This reference is used in the *A/D Converter* for digitizing the analog input signal.

A/D Converter. The *A/D Converter* is a dual-slope converter which digitizes the analog input signal using a ratiometric integrating technique. The analog signal input, a reference input, and a clock input are applied to the converter. The measurement cycle is divided into an *Auto-Zero* cycle, a *Signal Integrate* cycle, and a *Reference Integrate* cycle. Each cycle has a time base in which a certain amount of clock pulses occur. The clock used is a 100-kHz crystal oscillator. The *Auto-Zero* cycle is used to bring the output of the integrator to zero and lasts 10,000 counts. The next cycle is the *Signal Integrate* cycle which also lasts 10,000 counts. If the analog input is zero at the start of the *Signal Integrate* cycle, the integrator will see the same voltage that existed in the previous state. Thus, the integrator output will not change but will remain stationary during the entire *Signal Integrate* cycle. If the analog input is not equal to zero, an unbalanced condition exists compared to the *Auto-Zero* cycle and the integrator will generate a ramp whose slope is proportional to the analog input. At the end of this cycle, the sign of the ramp is determined. If the input signal was positive, a voltage which is VREF more negative than during *Auto-Zero* is applied to the integrator input. The *A/D Converter* chip generates the equivalent of a +*Reference* or –*Reference* from the single +*Reference* applied. The reference voltage returns the output of the integrator to zero. The time, or number of counts, required to do this is proportional to the input voltage. The *Reference Integrate* cycle can be a maximum of 20,000 counts. The full measurement cycle is then a maximum of 40,000 counts, with the answer to the measurement being achieved when the reference voltage returns the integrator output to zero. The full measurement cycle is shown in Figure 4.

The DIGIT DRIVES are positive-going signals that last for 200 clock pulses (see Figure 4). The scan sequence is D5 (MSD), D4, D3, D2, and D1 (last active digit). The scan is continuous unless an overrange occurs. Then all DIGIT DRIVES are blanked from the end of the first scan until the beginning of the *Reference Integrate* cycle when D5 will start the scan again. This gives a blinking or flashing display as a visual indication of overrange. Because the Digital Indicator has 5000 and 10000 ranges as well as a 20000 range, an analog *Overrange Comparator* is used as well as the inherent overrange capability of the *A/D Converter*. The *Overrange Comparator* is described in a following paragraph.

The binary-coded-decimal (BCD) outputs of the *A/D Converter* are positive logic signals that go on simultaneously with the DIGIT DRIVE. Since the DIGIT DRIVES are blanked for an overrange on the 20000 scale, the display will flash all zeros when this condition occurs on this scale.

Input Attenuators/Range Switches. The 5-volt analog signal input (full scale) and the 2.5 volt reference from the Signal Conditioner are applied to attenuator networks where 2-volt and l-volt signal and reference inputs are developed for the *A/D Converter*. Since, on the 20000 range, the *Reference Integrate* cycle can be

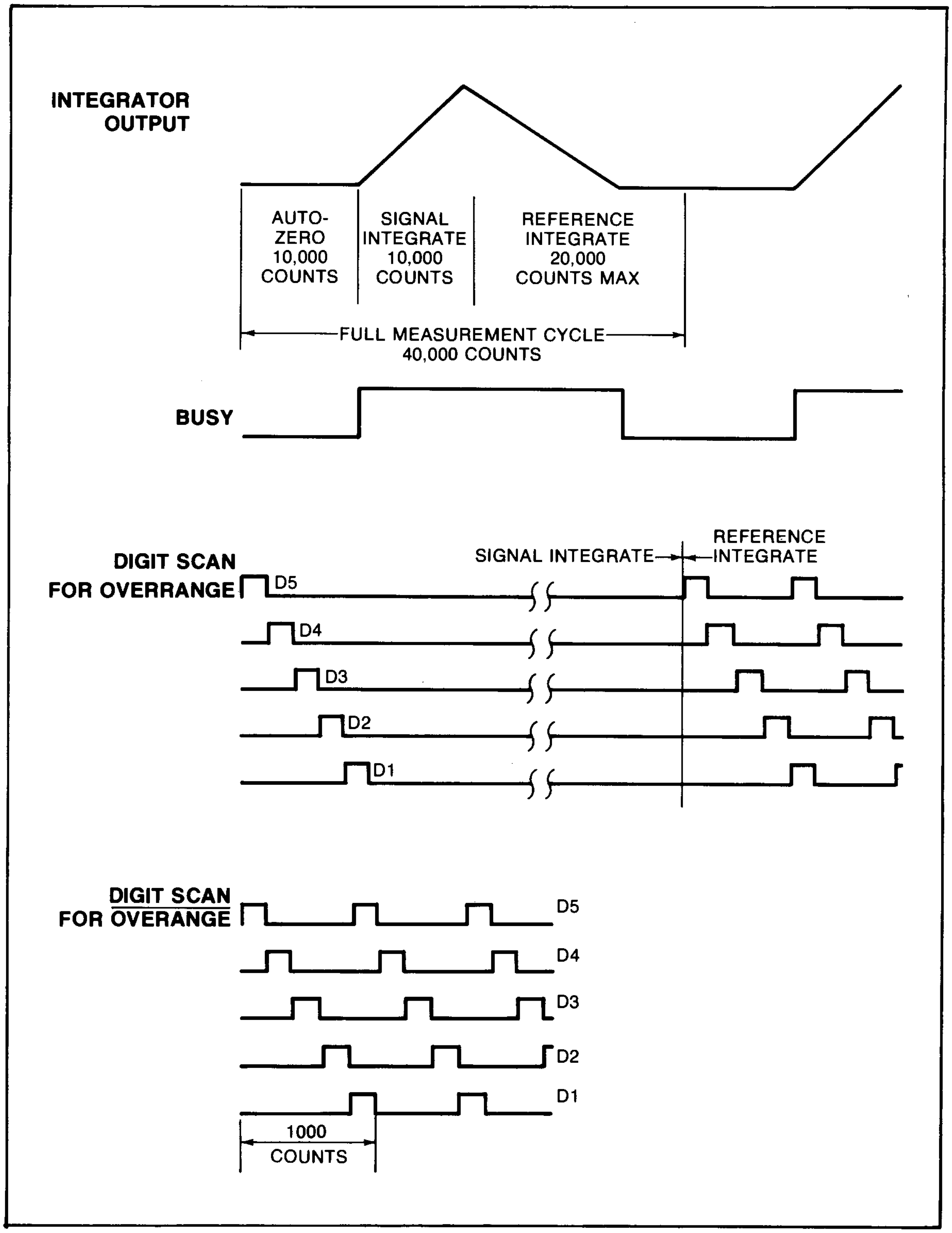

Figure 4. A/D Converter Timing Diagram

twice as long as the *Signal Integrate* cycle, the analog input voltage required to give a full-scale reading is exactly equal to 2 V_{REF}. Consequently, on the 20000 range, the V_{REF} is 1 volt and the V_{SIG} is 2 volts for full scale. On the 10000 range, the two cycles can be equal; thus, $V_{SIG} = V_{REF}$ = 2 volts. On the 5000 range, the analog voltage for a full-scale reading is then equal to 1/2 V_{REF}; thus, V_{REF} must be 2 volts and V_{SIG} 1 volt. The appropriate levels are switched to the *A/D Converter* through the rear-panel *Range* switches.

Bit Selector/Decoding Logic. The Bit Selector transfers one of two sets of 4-line BCD data applied at input ports to output ports upon receiving a command at the A SELECT or B SELECT port. When the A SELECT port is high, the X input data is transferred to the Z output ports. Conversely, when the B SELECT input is high, the Y input data is transferred to the Z output ports. The Y data is obtained directly from the BCD output ports of the *A/D Converter*. The X data is comprised of specially coded bits used to count by *2's* or *5's* when the 10000 or 20000 ranges are selected, respectively. On the 5000 range, the A SELECT input is held low through the *Range* switches and the B SELECT input is high. The Y data is transferred to the output of the *Bit Selector* and the display count is by *1's*. On the 10000 range, the A SELECT input is held low except when the Dl DIGIT DRIVE is high. When D1 is high, the A SELECT is high and the B SELECT is low, transferring the X data to the Z ports of the *Bit Selector* and allowing the display to count by *2's*. Operation on the 20000 range is identical except that the bit coding is arranged to give a count by *5's* with the X data.

Display Coding/Driving. The display is a 4.5-digit LED display with polarity and a dummy zero. DS2 through DS6 are 7-segment displays with common cathodes. The *Bit Selector* output ports are connected as inputs to a *BCD-to-7-Segment Decoder*. The 7 outputs of the decoder are connected as inputs to the segments (anodes) of DS2 through DS6. The DIGIT DRIVES of the *A/D Converter* are used to sequentially turn on DS2 through DS6 through *Display Drivers* which sink current. DS1 is either unlit or lights as a *1* for displays of 10000 or greater. Unlike DS2 through DS6, DS1 is a common anode device. The DS1 segments (cathodes) are sinked via a display driver from the *1 bit* of the *A/D Converter*. The DS1 anode is then brought high by D5 through a driver comprised of an inverter and a transistor which applies +6 volts unregulated to the anode when D5 is high.

The last digit of the Display (DS6) is the dummy zero digit. When the *Dummy Zero Select* switch is ON, the DS6 cathode is sinked when D5 is high. The outputs of the *BCD-to-7-Segment Decoder* are tied to the DS6 segments. Also, when D5 is high, the B SELECT input to the *Bit Selector* is pulled low through the NOR gate connected to the port. The A SELECT input is also low since it is either held hard low through the *Range* switches on the 5000 range or it is connected to D1 through the *Range* switches on the 10000 and 20000 ranges (when D5 is high D1 must be low). With the A SELECT and B SELECT inputs both low, the Z ports of the *Bit Selector* assume the low state no matter what the X and Y input data reads. Consequently, each time D5 is high, DS6 displays a zero.

The polarity sign is also part of DS1. The minus (-) segment is always lit through 6 volts and an external resistor tied to circuit common. When the *A/D Converter* senses a positive polarity, the POLARITY port goes high. This action drives an inverter low to light the vertical portion of the polarity sign.

Decimal point position is selected with rear-panel slide switches (as is dummy zero selection). Only one of the *Decimal* slide switches is turned ON at any one time. The decimal-point LED for DS1 is hard wired to +6 volts. Turning ON the associated *Decimal* switch connects an external resistor and circuit common to the other side of the decimal-point LED. Since the remaining digits with decimal-point LED's (DS2 through DS4) are common cathodes devices, each LED is sinked when the corresponding DIGIT DRIVE is high and associated *Decimal* switch is ON, applying +6 volts to the other side of the LED through an external resistor.

Analog Overrange. Digital overrange for the 20000 range is inherent in the A/D Converter chip and has been previously described. However, for the 5000 and 10000 ranges, an analog overrange circuit is required. The *Overrange Comparator* is dc biased with equal resistors returned to the ±9 volt supplies so that its output is at approximately 4.5 volts. Both of the comparator inputs are connected through diodes to the analog input from the Signal Conditioner. When the analog input is one diode drop above or below the comparator biasing, an overrange condition exists since approximately 5.2 volts is present at the analog input (5 volts = full-scale value). The output of the *Overrange Comparator* goes low when either of the input diodes is forward biased. The comparator output and the BUSY output of the A/D Converter are gated through an OR gate. The BUSY signal is high during the Signal and Reference Integrate cycles of the A/D Converter, then it goes low. This causes the output of the OR gate to go low. The BLANK port of the BCD-to-7-Segment Decoder is normally held high through an external resistor. When the OR gate output goes low, the BLANK port is pulled low through a diode, causing DS2 through DS6 to flash. Since DS1 is not driven from the decoder, a second diode and resistor are used to pull the *A/D Converter 1-bit* output low when the overrange OR gate is low. This action causes DS1 to flash.

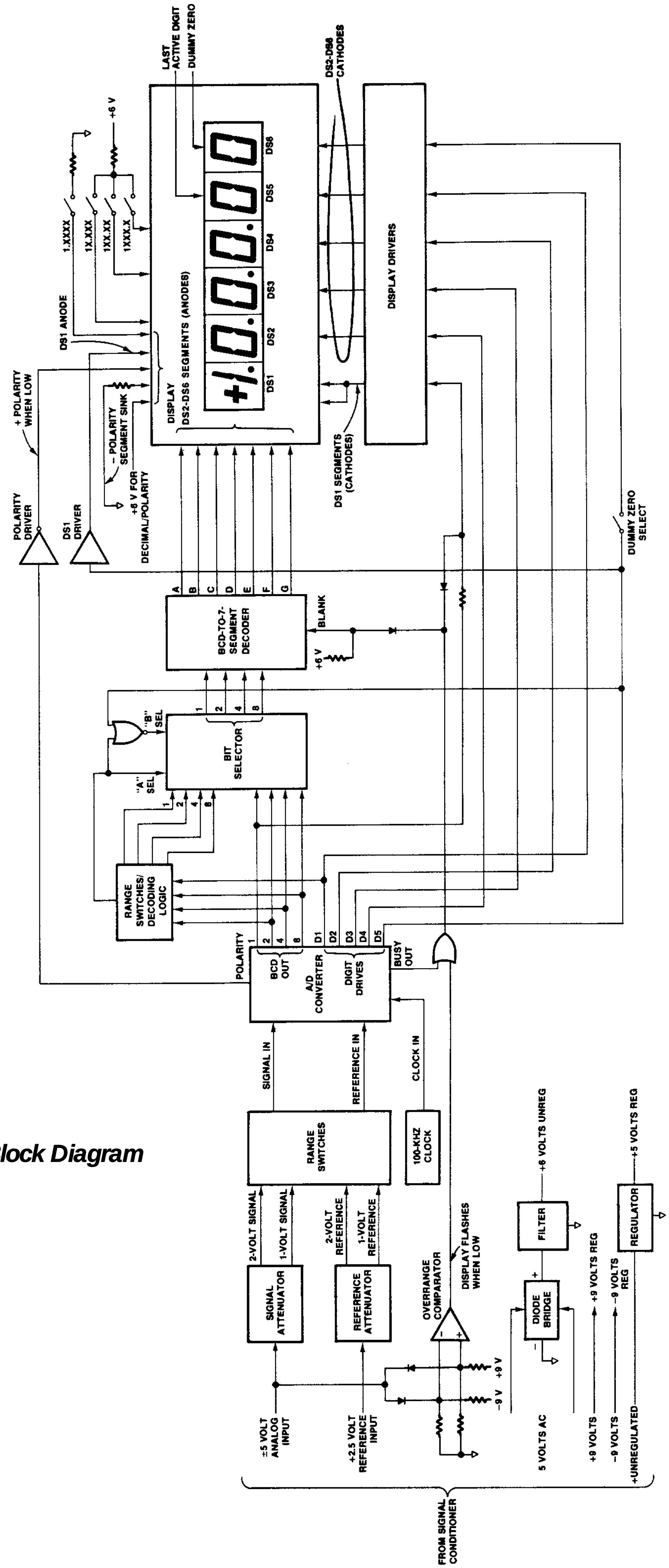

Figure 5. Block Diagram

5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in rapidly determining whether the Digital Indicator is functioning normally or whether it is the source of the observed trouble. In the event a repair to the Digital Indicator is required, a complete parts list, schematic diagram, and component location drawing are included in this manual. The user may also contact the factory Service Department or the local Daytronic Representative for assistance.

One of the two techniques can be used to rapidly determine whether the Digital Indicator is malfunctioning or whether the problem is in the Signal Conditioner, transducer, or transducer cabling. If the unit is a *Form 2* instrument (no Hi-Lo Limits), attempt to zero and calibrate the Signal Conditioner while observing the Signal Conditioner analog output (use the dc-to-2Hz output) on a dc coupled oscilloscope. If the Digital Indicator is unstable or reads erratically, but the oscilloscope indicates a stable analog output from the Signal Conditioner, the problem is likely in the Digital Indicator. In the event the Signal Conditioner output is unstable or noisy, consult the Signal Conditioner *Instruction Manual* for the proper action to be taken.

If the instrument is a *Form 3* type, push one of the Limit pushbuttons and observe how the limit value is displayed on the Digital Indicator. If the display is stable with the Limit button pressed, but is unstable when the button is released, the problem is in the Signal Conditioner, transducer, or transducer cabling. If the display is unstable or erratic whether the button is pressed or released, the problem is in the Digital Indicator.

Model 3300 Instruction Manual, v. SB.5
Pub. No. 3300M.5, Issued 10/96
Part No. 91131

DAYTRONIC

MODEL 3300 HI-LO LIMITS

INSTRUCTION MANUAL

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www.daytronic.com

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

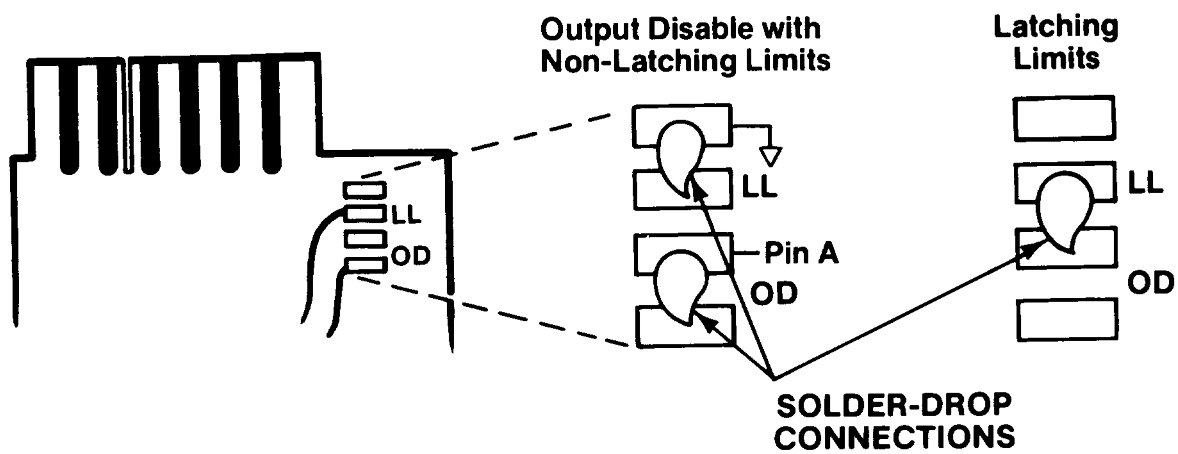
PLEASE NOTE: Sections 6 and 7, Figures 8 and 9, and Table 4 have been removed from this manual.

If you need information regarding specific 3330 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

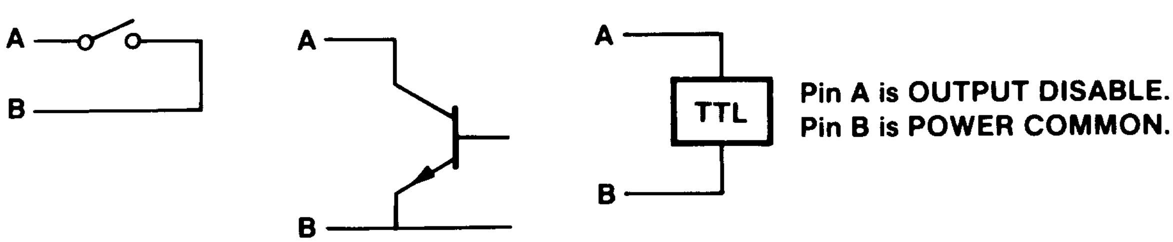
NOTE

The Model 3300 may operate in either of two modes: *Latching Limits* (LL), where limit logic outputs are held until application of an external *Reset* action, or *Output Disable* (OD), where limit logic outputs are *non-latching* being automatically disabled as soon as the *Violation* condition ceases.

Unless you have specified otherwise, your Model 3300 will have been preset *at the factory* for *non-latching* operation, through solder-drop terminals on the underside ("Side 1") of the printed-circuit board, as shown below. You may at any time, however, resolder the terminal connections as shown to produce *latching* limit outputs.



For *latching* operation, you must also provide an external means of resetting the limit outputs as soon as the condition(s) giving rise to the violation have ceased to exist, thus resetting the 3300 to continue normal limit monitoring. To reset *latched* limit outputs, Pins A and B of the *Limit Output Connector* (see Table 3, p. 8) must be connected by one of the three methods shown below:



In all discussions of limit logic outputs in this manual, "normal"—i.e., *Output Disable* —operation of the Model 3300 is presumed.

INSTRUCTION MANUAL
3300 SERIES HI-LO LIMITS

1. DESCRIPTION

The *3000 Instrument Series* is a family of premium signal conditioning instruments that includes models to accomodate virtually all types of transducers and signal sources commonly encountered in electro-mechanical testing and control operations. The *3000 Instruments* are available in three forms: *Form 1* contains the Signal Conditioner only; *Form 2* is the Signal Conditioner with Digital Indicator; *Form 3* is the Signal Conditioner with Digital Indicator and Hi-Lo Limits. The model numbering system used with the *3000 Series* identifies the form and the type of signal source. This numbering system is further explained in Table 1. From Table 1, it can be seen that all models having Hi-Lo Limits are identified by a 33XX number, with the last two digits identifying the type of signal source (thermocouple, LVDT, etc).

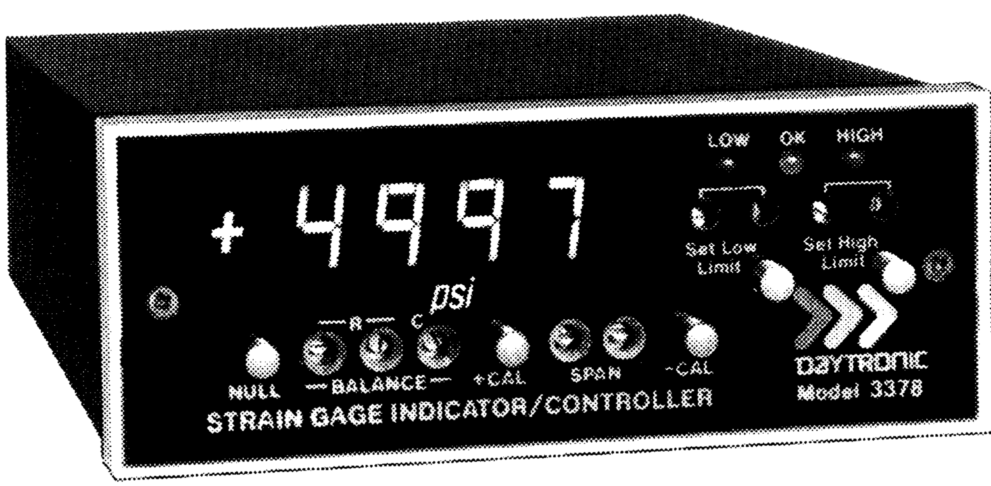


Figure 1. 3000 Series Instrument with Hi-Lo Limits

Table 1. 3000 Series Model Numbering

Model 3 X X X

"3" is series identifier, used with all units:

Second digit identifies "form":

"1" = signal conditioner only
"2" = signal conditioner with digital indicator
"3" = signal conditioner with digital indicator and Hi-Lo limits

Third and fourth digits identify type of signal source:

"10" = Type J Thermocouple
"11" = Type K Thermocouple
"15" = Thermistors
"30" = LVDT's
"40" = Pulse Pick-up's (Frequency)
"63" = DC Volts/Millivolts/
DC-DC LVDT's/Potentiometers
"70" = Strain Gages (DC excited)
"78" = Strain Gages (AC excited)
Etc.

The *3000 Series* instruction manual system is designed to provide the user with the following documentation: (1) a separate instruction manual for each type of Signal Conditioner purchased; (2) an instruction manual covering only the Digital Indicator section of a *3000 Series* instrument, but applicable to any *Form 3* instrument. It is the purpose of this manual to cover the Hi-Lo Limit section of all *Form 3* instruments.

The Hi-Lo Limit section of any *Form 3* instrument consists of the following: (1) an additional printed-circuit board on which are mounted the required circuit components for Hi-Lo Limit operation, (2) associated front-panel controls and indicators, and (3) a rear-panel connector where the *Limit* mode is selected and where *Limit* logic outputs can be obtained.

The *3300 Series* instruments can be used in any of three *Limit* modes. The *Low/OK/High* is the most common mode of operation and is used to detect when the analog signal drops below a *Low* limit or exceeds a *High* limit. The range in between limits is designated as OK. The second mode which can be used is the *Both Limits High* mode where both limits are above the OK range. The third mode is the opposite function, or the *Both Limits Low* mode, where both limits are below the OK range. In all three modes of operation, the limits can be set across the entire ± signal range (±5 volts). The instrument is shipped for operation in the *Low/OK/High* mode, but either of the other two modes can be easily selected by wiring of the rear-panel *Limit* output connector (see Section 2, Installation).

Both true and complement limit logic outputs are available at the *Limit* output connector for the *Low/OK/High* functions. The outputs are wire-ORable, TTL compatible (10 milliamperes sink, 0.5 milliamperes source). For *latching* limits, see NOTE, inside front cover.

Front-panel status indicators light to indicate when a limit is exceeded or when the analog signal is within the OK range. A red LED is used for each of the limits and a green LED is used as the OK indicator.

Coarse and *Fine* setting potentiometers are provided for each limit. Individual *Push-to-Set* buttons cause the limit value to be displayed by the Digital Indicator in the proper engineering units. A typical *3300 Instrument* is shown in Figure 1. The specifications for the *Limit* section are given in Table 2.

2. INSTALLATION

The *3000 Series* Instruments can be operated as bench-top instruments or they can be rack- or panel-mounted. Dimensions for all three types of mounting and corresponding mounting instructions are given in the accompanying Signal Conditioner *Instruction Manual*. The following paragraphs provide instructions for limit mode selection, input filtering, logic output connections, and ac power connection.

Table 2. Specifications

Limit Status Display: Individual red LED's indicate if limits are violated. Single green LED indicates no violations (analog signal within *OK* range).

Limit Setting: *Coarse* and *Fine* setting potentiometers provided for each limit. Individual *Push-to-Set* buttons also provided. When button is pushed, limit is displayed in proper engineering units on Digital Indicator.

Limit Logic Outputs: Both true and complement outputs provide for *Low/OK/High* functions. Outputs are TTL compatible, wire Orable; 10 ma sink, 0.5 ma source (max). Logic outputs are normally disabled when violation ceases to occur, but *latching* mode is also available (see NOTE, inside front cover).

Limit Modes: Three modes are available thru rear-panel *Limit* output connector wiring. Units shipped with *Low/OK/High* mode activated. *Both Limits High* or *Both Limits Low* mode can be user selected.

Output Disable: An *Output Disable* line provided which, if tied low, will cause all *limit* logic outputs to go high (both true and complement for each function).

Limit Mode Selection. Figure 2 illustrates the three modes in which *3300* Instruments can be operated. The unit is shipped from the factory with the *Low/OK/High* mode activated. In this mode, the *Low* limit is set some increment below the *High* limit. The increment between limits is the *OK* range. Either limit can be set positive or negative, as long as the *Low* limit is more negative than the *High* limit. When the *High* limit is exceeded, the front-panel LED status indicator (red) marked HIGH will light. When the analog signal drops below the *Low* limit, the front-panel LED status indicator (red) marked LOW will light. When the signal is between the two limits, the front-panel status indicator (green) marked OK will light. In this mode, only one of the three status indicators will light at any one time.

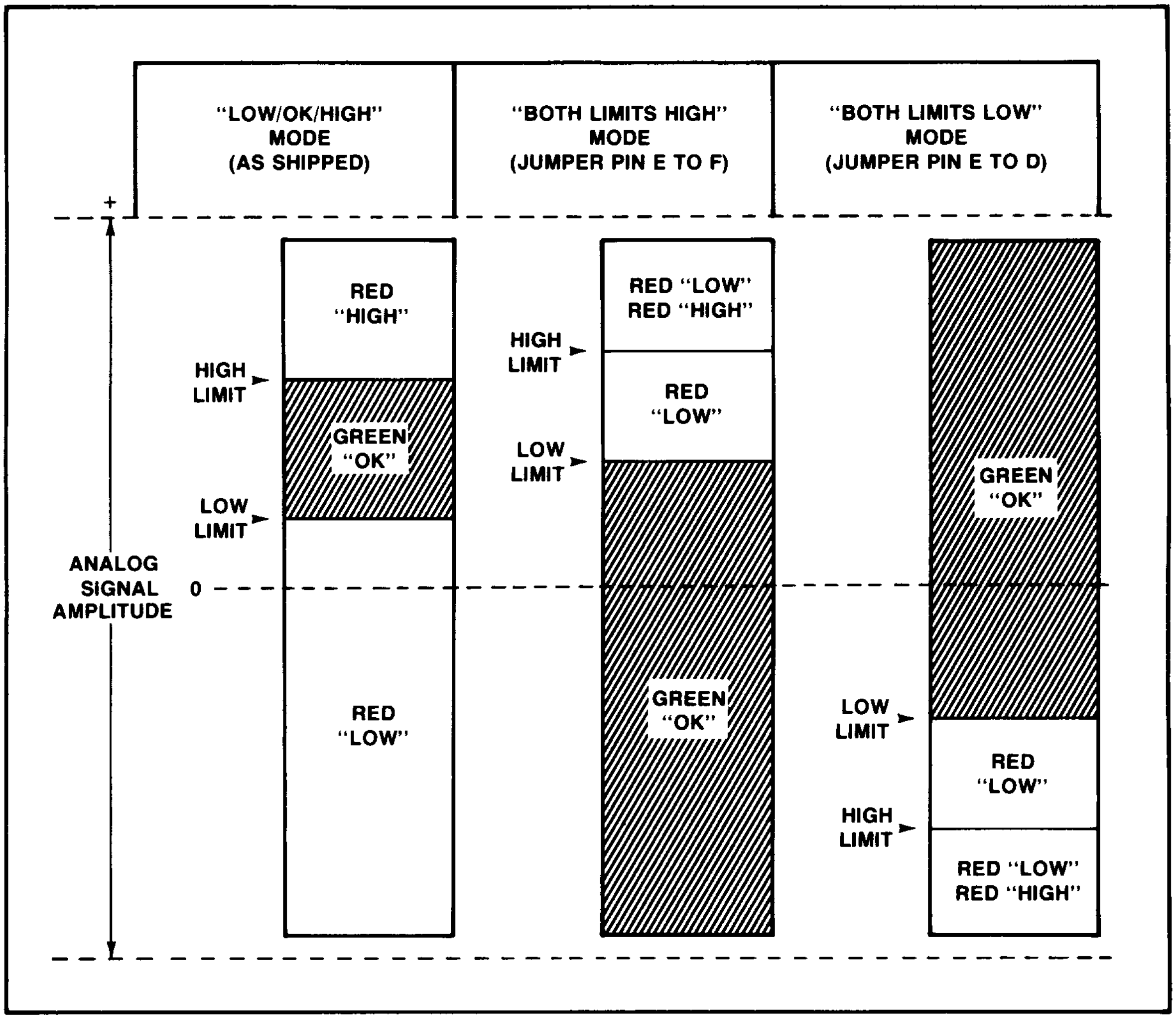


Figure 2. Limit Modes

To activate the *Both Limits High* mode, jumper pin E to pin F at the supplied rear-panel *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more positive than the Low limit. When the analog signal is below or more negative than the *Low* limit, the green OK indicator will light. When the *Low* limit is exceeded, the red LOW indicator will light (green OK will extinguish). When the *High* limit is exceeded, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are exceeded. When the signal drops below the *High* limit (but not the *Low* limit), the LOW indicator will remain lit. When the signal drops below the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

To activate the *Both Limits Low* mode, jumper pin E to pin D at the *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more negative than the *Low* limit. This mode works exactly opposite to that described in the preceding paragraph. When the analog signal is above or more positive than the *Low* limit, the green OK indicator will light. When the signal drops below the *Low* limit, the red LOW indicator will light (green OK will extinguish). When the signal drops below the *High* limit, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are violated. When the signal rises above the *High* limit (but not the *Low* limit), only the LOW indicator will remain lit. When the signal rises above the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

Input Filtering. Two filtered outputs are brought from the Signal Conditioner printed-circuit board to the Limit printed-circuit board. Both are low-pass filter outputs with one having a cutoff frequency of 200 Hz (*fast* signal) and the other having a cutoff frequency of 2 Hz (*slow* signal). The fast signal is normally connected to the Limit board circuitry via a solder-drop terminal labelled *F* on the underside (*Side 1*) of the Limit board (all 3300 units are shipped with this connection made). Instrument operation should be attempted without removing this connection. However, if excessive limit *chattering* is encountered (transducr is subject to excessive vibration etc.), this conection should be removed and the *slow* signal terminals should be connected via a solder drop. The *fast* and *slow* signal solder-drop terminals are illustrated in Figure 3.

Logic Output Connections. Logic outputs are provided at the *Limit* output connector for the *Low/OK/High* functions. Both true and complement outputs are provided that are TTL compatible (10 millamperes sink, 0.5 millamperes source maximum). These outputs may be used to trigger alarms or sort/reject devices etc. Typical wiring to these outputs to obtain a contact closure is shown in Figures 4 and 5. In Figure 4, wiring to a Daytronic 9399 Triac Controller is illustrated. Notice that while a variety of logic configurations can cause a contact closure, that current is always sinked by the *3300* instrument. If a device other than the 9399 is used, a resistor must be placed in series with the +5 volt line from the 3300 to limit the sink current to 10 milliamperes maxium.

Figure 5 shows the wiring and external circuitry when it is desired to close an external relay contact using source current. Only a Q output is used in this configuration and the source current drawn must be limited to 0.5 milliamperes maximum.

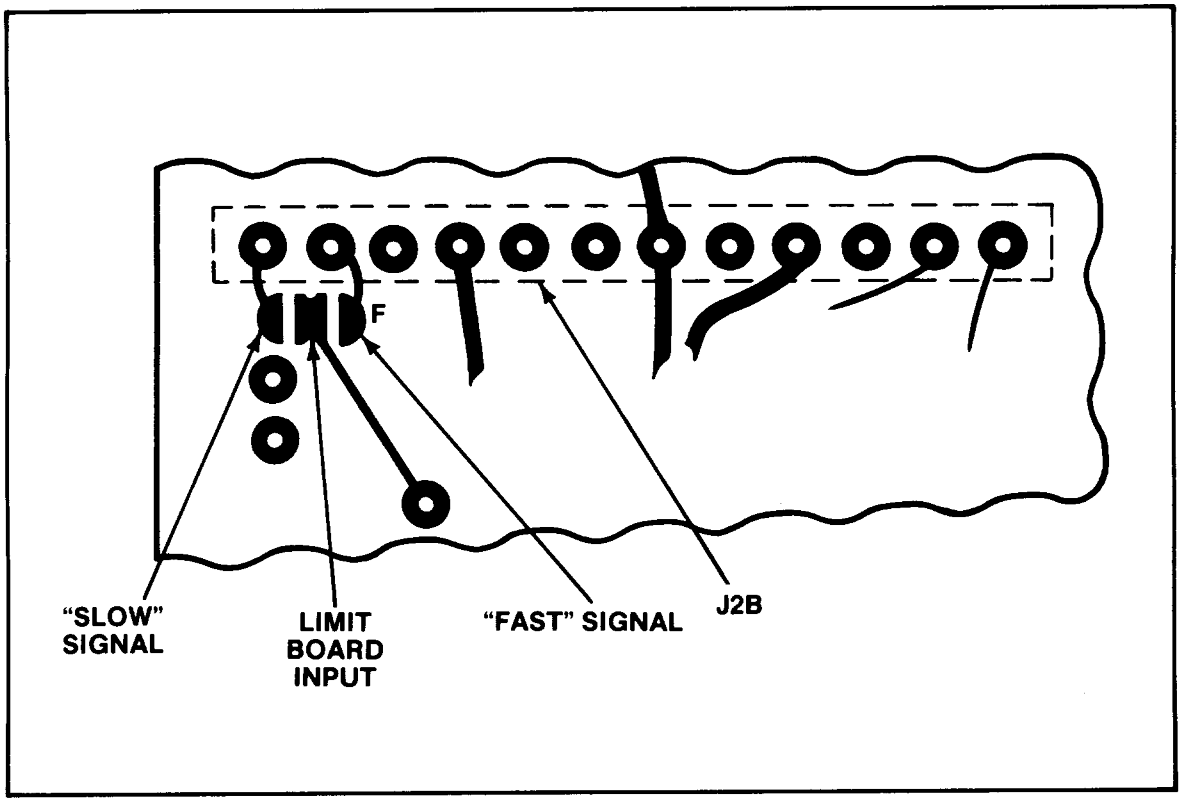


Figure 3. Fast/Slow Signal Solder-Drop Terminals

An *Output Disable* is also provided at the *Limit* output connector (pin A). When pin A is jumpered to pin B (common), all logic outputs (true and complement) are held high (+5 volts). Table 3 gives a listing of the functions available at the *Limit* output connector and the corresponding pin numbers.

AC Power Connection. To protect operating personnel, the *3000 Series* Instruments are equipped with a three-conductor power cord. When the cord is plugged into the appropriate receptacle, the instrument is grounded. The offset pin on the power cord is ground. To maintain the safety ground when operating the instrument from a two-contact outlet, use a three-prong to two-prong adaptor and connect the green pigtail on the adaptor to ground.

To prepare the instrument for operation, connect the power cable to a 105-135 volt ac, 50-400 Hz power source. The instrument can use up to 5 watts of power.

Table 3. Limit Output Connector Functions/Pin Nos.

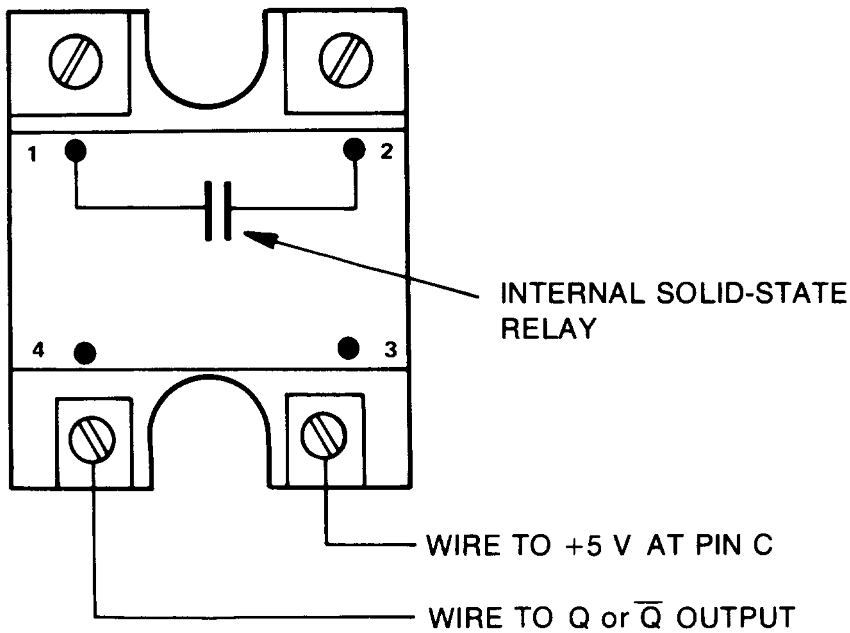
Function	Pin Number
+5 volts	C
Common	B
Limit Select	E
Both Lo	D
Both Hi	F
Output Disable	A
Q_{Lo}	5
$\overline{Q}_{Lo}$	6
Q_{Hi}	1
$\overline{Q}_{Hi}$	2
Q_{OK}	3
$\overline{Q}_{OK}$	4

Note: Jumper E to F to enable *Both Limits High* mode. Jumper E to D to enable *Both Limits Low* mode. No connection to E enables *Low/OK/High* mode.

3. OPERATION

The only operation required is turning ON/OFF ac power and setting the desired limits. These operations are described in the following paragraphs. Figure 6 provides a functional description of the front-panel.

Power On/Off. AC power is turned ON/OFF the instrument by means of a rear-panel slide switch. The digital display lights immediately when ac power is ON.



1. Wire pin 4 of 9399 to $\overline{Q}_{Hi}$ or $\overline{Q}_{Lo}$ output for contact closure at violation of limit.

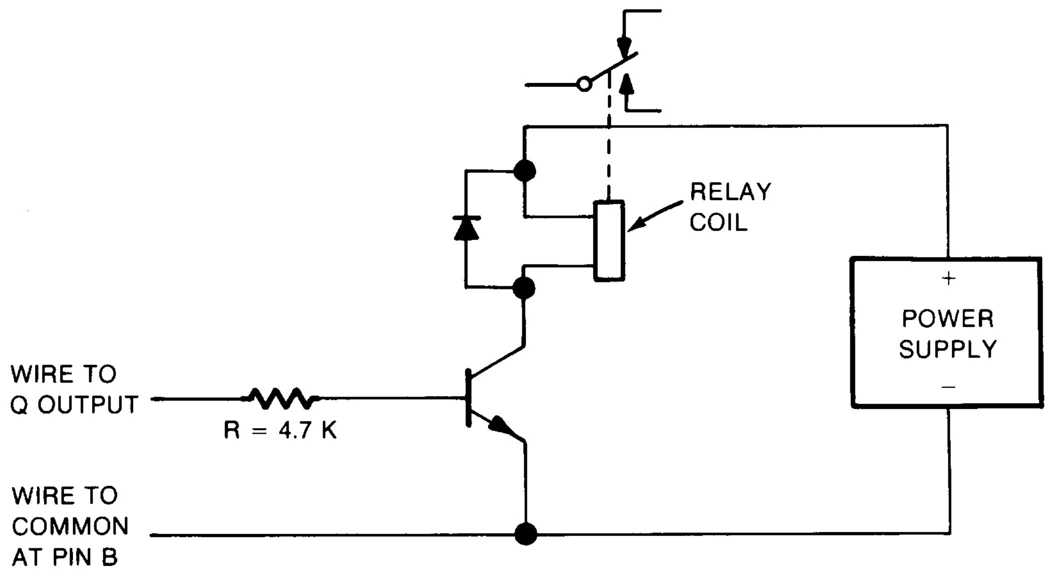
2. Wire pin 4 of 9399 to Q_{Hi} or Q_{Lo} output for contact closure with no violation.

3. Wire pin 4 of 9399 to $\overline{Q}_{OK}$ output for contact closure with no violation.

4. Wire pin 4 of 9399 to Q_{OK} output for contact closure at violation.

5. If Triac Controller other than 9399 is used, make certain sink current does not exceed 10 ma for TTL outputs.

Figure 4. Model 9399 Triac Controller Wiring



1. Wire to Q_{Hi} or Q_{Lo} for contact closure at violation of limit.
2. Wire to Q_{OK} for contact closure with no violation.

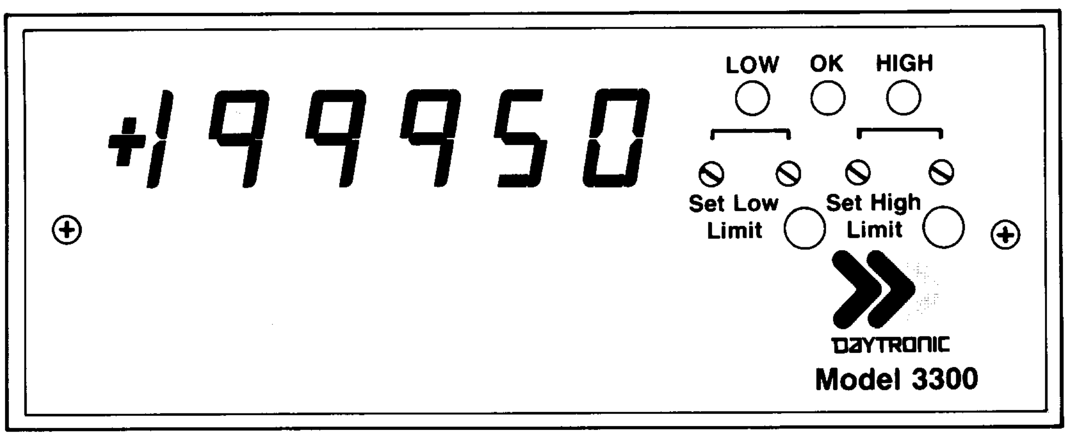
Figure 5. External Relay Driver Wiring

Limit Setting. Before setting the *Low* and *High* limits, the user should refer to Section 2 of this manual and become familiar with the limit mode in which the instrument is to be operated. Figure 2 illustrates the three operating modes by giving a graphic representation of typical limit settings. The *Limit* logic outputs wiring should also be reviewed before attempting to operate the instrument. This information is also contained in Section 2. To prevent inadvertent triggering of external circuits while setting the limits, remove the rear-panel *Limit* output connector. The connector can then be replaced after the proper limits have been set. To set the limits, proceed as follows:

(a) Press the *Set Low Limit* button and adjust the *Coarse* and *Fine Low* limit controls until the desired *Low* limit value is displayed on the Digital Indicator.

(b) Press the *Set High Limit* button and adjust the *Coarse* and *Fine High* limit controls until the desired *High* limit value is displayed on the Digital Indicator.

(c) The limits are now set and the appropriate LOW and HIGH status indicators will light when a violation of the limit occurs. The OK indicator will be lit when there is no violation. **NOTE:** For the front-panel status indicators to have meaning as marked, the *Low* limit must be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. In the *Both Limits Low* mode, the *Low* limit must be set more positive than the *High* limit for the terminology to have meaning.



LOW Status Indicator: Red LED which lights to indicate when ***Low*** limit is violated.

OK Status Indicator: Green LED which lights to indicate when limits are not violated.

HIGH Status Indicator: Red LED which lights to indicate when ***High*** limit is violated.

Coarse and Fine Limit Controls: Individual controls are provided for setting the ***High*** and ***Low*** limit values.

Set Low Limit Button: When pressed, causes the ***Low*** limit value to be displayed on the Digital Indicator.

Set High Limit Button: When pressed, causes the ***High*** limit value to be displayed on the Digital Indicator.

Figure 6. Front-Panel Description

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Limit circuits work by using a simplified block diagram. This section is not intended to provide a detailed explanation of electronic circuits for personnel untrained in electronic technology. However, it provides an adequate overview of operation for those familiar with basic electronic circuit operation. Throughout the following, refer to Figure 7.

A +2.5 volt precision *Reference* is supplied from a precision power supply located on the Signal Conditioner circuit board. This *Reference* is supplied as an input to a non-inverting amplifier from which the voltages are developed which are used for limit setting. A +5.6 volt level is obtained at the output of the *Reference Amplifier* and a -5.6 volt level is generated through the use of a *Unity Gain Inverter.* The ±5.6 volt levels are then applied across the *Fine* and *Coarse* limit potentiometers. The potentiometer wipers are summed together, then applied as non-inverting inputs to *Buffer Amplifiers* (one for the *Low Limit* channel and one for the *High Limit* Channel). Each *Buffer Amplifier* output is wired to a normally-open contact of a *Set Limit* pushbutton. When either pushbutton *(Set Low Limit* or *Set High Limit)* is pressed, the limit value is connected as an input to the Digital Indicator (analog output from the Signal Conditioner is disconnected from the Digital Indicator input). While the limit value is displayed on the Digital Indicator, the appropriate value can be set with the *Fine* and *Coarse* limit potentiometers. The *Buffer Amplifier* outputs are applied as inputs to a pair of voltage *Comparators.* The analog output from the Signal Conditioner is applied to each of the remaining *Comparator* inputs. When the signal is less than the limit set point, a *Comparator* output will be at a *logic 1* level (+9 volts). When the signal is greater than the limit set point, a *Comparator* output will be at a *logic 0* level (-9 volts).

Filtered outputs from the Signal Conditioner are applied to the Limit printed-circuit board. Both dc-to-200 Hz and dc-to-2 Hz analog outputs are provided. The 200-Hz signal is referred to as the fast signal and is normally connected to the limit circuits via a solder-drop connection. The 2-Hz signal, or *slow* signal, can be connected as an input to the limit circuits by unsoldering the *fast* signal solder terminal and soldering the *slow* terminal to the limit circuit input terminal. This is usually accomplished if limit *chattering* is encountered during operation. The *fast* signal is always connected to the limit input at factory fabrication.

Limit mode selection is accomplished by connecting the *Both Limits High* line or the *Both Limits Low* line to the *Limit Select* line (-9 volts) at the *Limit* output connector. The unit is shipped with neither of these connections made, automatically enabling the *Low/OK/High* mode. Exclusive OR logic is used to detect a violation. Two exclusive OR gates are used with a *60-Hz Filter* inserted between gates (diode-capacitor peak detector) to eliminate any ripple which might cause false triggering of the logic.

The first gate in the *Low Limit* channel has an input held low (thru an inverter whose input is tied high with a pull-up resistor) when the *Low/OK/High* mode is operational. When the analog signal is less than the set point, the remaining input to the gate is high. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is less than the set point. Since this is the condition for a violation of the *Low* limit in the *Low/OK/High* mode, the LOW lamp (red LED) is lit through an inverter.

The first gate in the *High Limit* channel has an input held high (thru a pull-up resistor) when the *Low/OK/High* mode is operational.. When the analog signal is greater than the set point, the remaining input to the gate is low. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is greater than the set point. Since this is the condition for a violation of the *High* limit in the *Low/OK/High* mode, the HIGH lamp (red LED) is lit through an inverter.

The gated outputs of the *Low* and *High Limit* channels are ORed together to light the OK lamp (green LED). Both outputs must be low (no violation) to take the OR gate output high. With this output high, the OK lamp is lit through an inverter.

When the *Both Limits High* line is tied to the *Limit Select* line (-9 volts), the input to the first gate in the *Low Limit* channel is held high through the inverter. This reverses the logic and causes the *Low Limit* channel to be violated by an increasing analog signal. Operation of the *High Limit* channel remains as before, and the OK lamp lights when the signal is below both of the set points.

When the *Both Limits Low* line is tied to the *Limit Select* line, the input to the first gate in the *High Limit* channel is held low. This reverses the logic and causes the *High Limit* channel to be violated by a decreasing signal. Operation of the *Low Limit* channel remains as in the *Low/OK/High* mode, and the OK lamp lights when the signal is above both of the set points.

Both true and complement outputs are provided for the *Low/OK/High* functions. These outputs are provided via a hex inverter chip with open-collector outputs. The open collectors are tied to +5 volts via pull-up resistors to provide TTL compatible outputs. An *Output Disable* line is provided which takes all outputs to +5 volts when tied to circuit common. This removes the +9 volts operating voltage from the hex inverter chip so that the outputs go to the pull-up resistor voltage of +5 volts.

The ±*9 Volts Regulated* is supplied from power supplies contained on the Signal Conditioner circuit board. The *+5 Volts Regulated* is developed by a three-terminal *Regulator*. The *Unregulated* input to the *Regulator* is obtained from the Signal Conditioner circuit board (unregulated side of +9 volt supply). The +9 volt supplies are discussed in the Signal Conditioner *Instruction Manual.*

5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in rapidly determining whether the limit circuits are functioning normally or whether they are the source of the observed trouble. In the event a repair to the limit circuits is required, a complete parts list, schematic diagram, and component location drawing are included in this manual. The user may also contact the factory Service Department or the local Daytronic Representative for assistance.

(a) Make certain that the desired limit mode has been properly selected and that the limits have been set according to the front-panel terminology. The *Low* limit should be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. The *Low* Limit should be set more positive than the *High* limit when the *Both Limits Low* mode is used.

(b) Make certain that some input is provided to the Signal Conditioner so that the Digital Indicator is reading a value off zero in the direction of the *Low* limit.

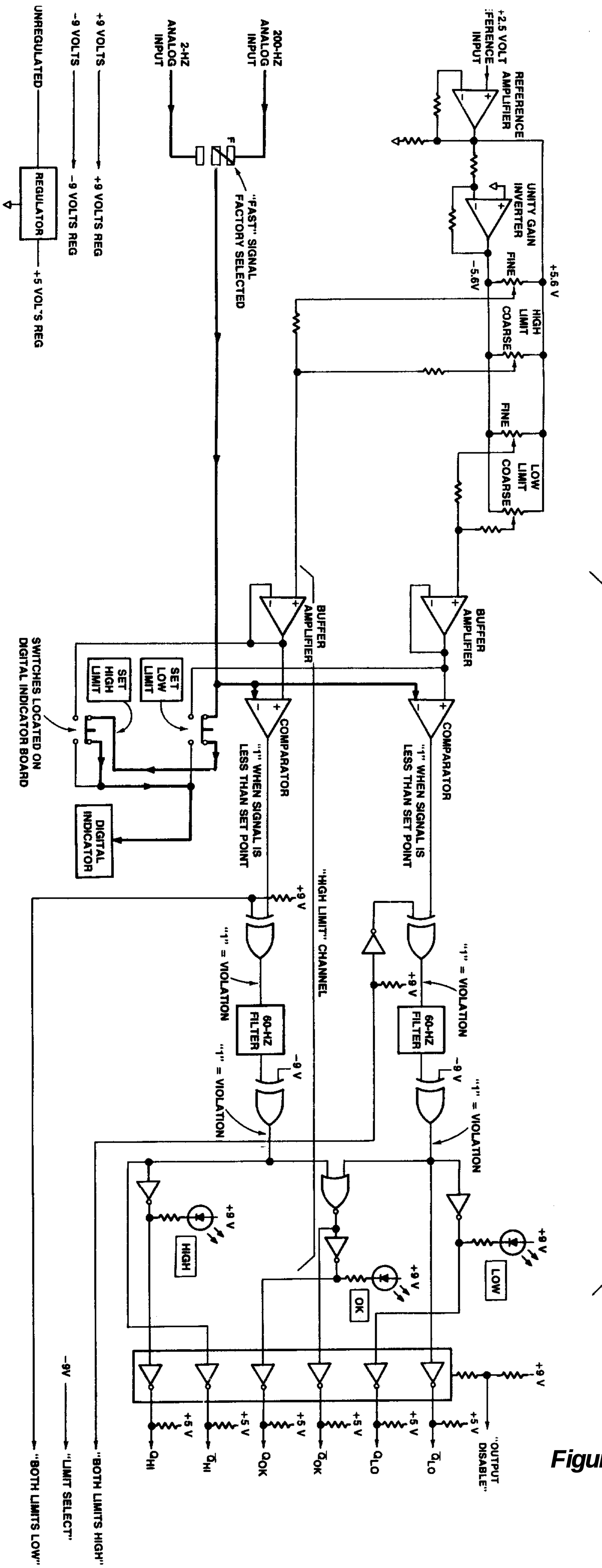


Figure 7. Block Diagram

(c) Adjust the *Coarse* and *Fine Low Limit* controls until the LOW indicator lights. Using the *Fine* control, backoff the limit until the LOW indicator extinguishes; then, readjust the *Fine* control until the indicator lights again.

(d) Press the *Set Low Limit* button. The Digital Indicator should have the same reading that was previously displayed for the Signal Conditioner output. This indicates that it is possible to set a limit value equal to the Signal Conditioner Output and that the violation is being sensed.

(e) Increase the Signal Conditioner output toward the value of the *High* limit and repeat the procedure of steps (c) and (d) using the *High Limit* controls to check the *High* limit operation. If the *Low/OK/High* mode is being used, only one front-panel status indicator will be lit at any one time. The green OK indicator will light in the range between limits. If either of the remaining two modes are in use, when the HIGH indicator is lit, the LOW indicator will also be lit. When both the LOW and HIGH indicators are extinguished, the OK indicator will be lit.

(f) If the front-panel indications show that the limits are properly functioning, but external circuits are not being properly triggered, check the wiring to the *Limit* output connector. If a wiring error cannot be found, remove the external circuit connections and check the logic output levels while repeating steps (c) thru (e). Refer to table 3 for output functions and pin numbers of the *Limit* output connector. The Q outputs should be true (+5 volts) when the corresponding status indicator is lit.

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